APPLIED MECHANICS Reviews

A CRITICAL REVIEW OF THE WORLD LITERATURE IN APPLIED MECHANICS AND RELATED ENGINEERING SCIENCE

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APPLIED MECHANICS REVIEWS

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DISSEMINATION OF SCIENTIFIC INFORMATION*

G. MILES CONRAD

DIRECTOR, BIOLOGICAL ABSTRACTS
PRESIDENT, NATIONAL FEDERATION OF SCIENCE ABSTRACTING AND INDEXING SERVICES

Editor's note: In view of the importance of providing effective and adequate reviewing and abstracting service to the members of the scientific community, and in view of the participation of AMR in the activities of the Federation, we felt our readers might find this "status report" to be of interest.

In reviewing the problems of providing American scientists with scientific information developed in foreign countries it is essential to examine both the size of the output of research information throughout the world and the languages in which this information is published.

With regard to the language problem we are most fortunate in having access to an exceptionally interesting monograph published in 1957 by UNESCO, edited by J. E. Holmstrom, and entitled, *Scientific and Technical Translating and Other Aspects of the Language Problem.* In this detailed analysis of the languages of science, several chapters are devoted to a review of the principal languages used by scientists and an assessment of the shifts in usage of some of the languages in accordance with shifts in research emphasis in the various nations and areas of the world.

Table 1. shows quickly that those of us who read English are most fortunate, indeed, for in all of the broad fields of science more material is published in that language than in any other. Further, a reading knowledge of French and German—traditional language tools of the trained scientist—gives most American scientists reasonably ready access to the large majority of the world's research journals.

To further minimize the problem of the communication of foreign scientific information, many of those publications issued in the less widely read languages are available to American scientists through the simultaneous publication with the original article of summaries in English, German, or French. Thus, of the approximately 150 journals of biological interest published in Japan, about 80% are available, in part at least, to readers of English; 15% to readers of German; and 4% to readers of French. Similarly, of the 60-odd journals of biological interest published in Sweden, parts of 80% are available in English; 56% in German; and 37% in French. The same situation tends to prevail among the journals published in the less common languages of science, such as Dutch, Danish, Icelandic, Finnish, Turkish, Hebrew, Chinese, Arabic, etc. Knowledge of Spanish and Italian, while not normally a part of the equipment of the average American scientist, is widespread enough in the United States so that access to scientific information in those languages presents little difficulty.

It appears, then, that the major linguistic problem for American science lies in the area of the Slavic tongues and those of the Orient. We have seen that the growing scientific literature of Japan is currently readily available to American scientists through the widespread use of English by the Japanese. The scientific literature of southeast Asia and the Malay region is negligible; that of India and Pakistan is in English; but what of China? Correspondence by several members of the *National Federation of Science Abstracting and Indexing Services* with the Institute of Scientific Information of the Academia Sinica in Peking tells us that of the 74 journals that are apparently being currently published in China; three are published in English; 35 are published in Chinese, but with abstracts in western languages; and 36 are published in Chinese alone.

The foregoing brief review tends to show, I believe, that American scientists have rather easy access to the vast ma-

Table 1. Percentage of Scientific and Technical Journals Published in the World's Major Languages

(Modified from J. E. Holmstrom, *Scientific and technical translating and other aspects of the language problem.* UNESCO, Paris, 1957)

	ENGLISH	FRENCH	GERMAN	RUSSIAN (and others using Cyrillic alphabet	SPANISH	ITALIAN	JAPANESE	PORTUGUESE	ALL OTHERS
Botany; zoology; microbiology	43%	10%	18%	13%	6%	1%	1%	...	8%
Medicine; pharmacy; etc.	40%	11%	15%	7%	8%	7%	2%	2%	8%
Agriculture; forestry; fisheries; etc.	49%	12%	14%	5%	5%	4%	0.5%	0.5%	10%
Mathematics; astronomy; physics; etc.	40%	15%	17%	8%	2%	2%	2%	...	14%
Chemistry and metallurgy	42%	11%	15%	9%	4%	6%	2%	...	11%
Geology; meteorology; paleontology	26%	15%	14%	19%	7%	...	4%	3%	12%
Engineering; building; transport; etc.	53%	13%	16%	2%	3%	5%	1%	1%	6%
Manufactures: leather, plastics, rubber, etc.	52%	21%	15%	2%	2%	...	...	...	8%

*Condensed and modified from a Statement for the U. S. Congress House of Representatives Committee on Science and Astronautics Regarding the Dissemination of Scientific Information presented June 2, 1959.

jority of scientific research writings through a knowledge of English, German and French—even when, occasionally, their needs send them into literature published in the more obscure languages. At present the major exception is, of course, Russian and its related tongues. (Even here, however, there has been a recent tendency to provide summaries in western languages.) Scientific developments in Russia have always been reported by the abstracting and indexing services of science—the current problem results not from the fact that this information is written in an unfamiliar alphabet and a strange language, but rather because of the burgeoning amount of Russian scientific publication that has burst upon the world in recent years.

The social and economic climate for the development of of science and research has continued most favorable throughout the nineteenth century and the first half of the twentieth in western Europe and the United States. This fact undoubtedly accounts for the ready accessibility to most information by those who read English, French and German.

From appearances, the climate for research and the development of science was not as favorable in Russia during this same period. However, it is increasingly evident that through the raising of the general level of education and the need to pursue scientific and technologic research for its material values, Russia is just now entering upon a new upsurge of research activity with its attendant increase in publication. This tardy entrance into the widespread and enthusiastic pursuit of science becomes immediately evident from a study of the growth in the number of scientific and technical publications published in the United States and in Russia since 1800. Thus,

Percentage of the present total of journals published:

Year	In the U. S. A.	In the U. S. S. R.
1800	0.06%	0.0 %
1810	0.06%	0.0 %
1820	0.08%	0.0 %
1830	0.17%	0.09%
1840	0.25%	0.2 %
1850	0.47%	0.2 %
1860	0.64%	0.2 %
1870	1.4 %	0.7 %
1880	3.0 %	0.8 %
1890	6.0 %	1.2 %
1900	10.0 %	1.4 %
1910	16.0 %	2.2 %
1920	44.0 %	3.9 %
1930	57.0 %	14.5 %
1940	70.0 %	40.0 %
1950	95.0 %	95.0 %
1952	100.0 %	100.0 %

Lest at first glance the foregoing table be not too clear, an example will serve to illustrate its meaning. Thus, in 1920, 44% of the scientific and technical journals now published in the United States were in existence, but it was not until more than twenty years later (in 1943, actually) that Russia reached this relative point in the development of its scientific periodicals. In absolute numbers of publications, of course, the United States has a substantial lead over Russia, as shown in Table 2. However, the rate at which scientific publication in the two countries is growing suggests that Russia may soon draw abreast of and may even surpass the United States.

There are at present being published in Russia probably from 1800 to 2000 scientific and technical periodicals. To provide access to this literature, some have advocated the so-called "cover-to-cover" translation of journals. Through this program, to a large extent financed by the federal government, American scientists have direct access to 68 translated journals, or only about 3½%! Obviously, this can be little more than a stop-gap solution to the present and future problem. The only practical and realistic solution lies in the

Table 2. The number of periodicals and fields of science and technology covered by the publications of the Soviet Union (1945–1953), China (1905–1955), and the United States (1950–1953)*

	Soviet Union	China	United States
General Science	139	104	163
Physical Sciences	164	18	286
Earth Sciences	158	77	295
Life Sciences	200	63	496
Agriculture	337	131	954
Medicine	303	75	1,016
Engineering & Technology	708	179	1,319
Totals	2,009	647	4,529

(Because of multiple entries these totals are greater than the actual number of journals published in each country.)

*Data compiled from the following references:

1. *Scientific and Technical Serial Publications: Soviet Union, 1945–1953.* Science Division, Library of Congress, Washington, 1954.
2. *Chinese Scientific and Technical Publications in the Collections of the Library of Congress.* Science Division, Library of Congress, Washington, 1955.
3. *Scientific and Technical Serial Publications: United States, 1950–1953.* Science Division, Library of Congress, Washington, 1954.

training of young scientists in the Russian language—not, however, at the expense of French and German, for the latter are still very significant languages for science.

Although the total number of Russian publications is large, it represents only four or five per cent of the possible total of 50,000 periodicals published throughout the world. Are we not unduly concerned with Russian scientific information? Have not national and linguistic origins of scientific information always been a problem? How has the world's scientific information been disseminated in the past?

These, and similar questions, are probably best answered by a review of the process of what has come to be called the documentation of science.

The conveying of scientific information from producer to user follows several well-defined steps that have been developed over the years and have come to be accepted by all of the world's scientists. A scientist, having completed a particular body of research, submits a report for publication to what is called a "primary" journal. His report and the journal to which he submits it are usually in his mother tongue. If this tongue is one of the widely used western languages that is all the reporting scientist will use. If, however, the report is written in a less well-known language the scientist-author (or his editor) will often provide in addition a summary of the research in some language that his foreign colleagues are more likely to understand.

If the primary journal were then widely circulated there would be some chance that the report would reach the eyes of interested but unknown colleagues throughout the world who would understand and make use of the information. Almost invariably, however, the "primary" journals in which research reports are published are very limited in their circulation—500 copies or less is not unusual—and this small circulation is often limited to the nation of origin, although a few copies of most do find their way into the collections of the few truly great libraries of the world. In general, though, only the author's own local colleagues would ever learn of the existence of his research report if it were not for the abstracting and indexing services.

It was in order to minimize this possible loss of scientific knowledge by ensuring the international dissemination of scientific information that abstracting and indexing services came into being. As early as 1807 in the field of geology and mineralogy this need was felt and the first abstracting service was established in Germany. Throughout the intervening 150 years many additional abstracting and indexing journals

("secondary publications") have been established to serve the ever-increasing number of sciences. Sometimes these services have been established by great libraries where a majority of the world's periodicals in a field of science are received—for example, the *Bibliography of Agriculture,* published by the United States Department of Agriculture Library, and *The Current List of Medical Literature,* published by our National Library of Medicine. Some abstracting and indexing services are sponsored by scientific societies, such as *Chemical Abstracts,* published by the American Chemical Society; *Meteorological Abstracts,* published by the American Meteorological Society; or the *Zoological Record,* published by the Zoological Society of London. My own service, *Biological Abstracts,* is one of the very few that is completely independent of either a library or a scientific society. It was established as an independent, nonprofit, cooperative venture of the world's biologists and incorporated through the joint efforts of the National Academy of Sciences, the American Association for the Advancement of Science, and the Union of American Biological Societies. This is mentioned in order to show that the very existence of the abstracting and indexing services reflects the importance that organized science attaches to the need for the international communication of scientific information.

Let us return to the scientist-author whose research has been published in the limited-circulation "primary" journal. His article will now be abstracted, indexed and distributed in abstract form throughout the world by the appropriate abstracting and indexing service, or services. For example, if Dr. Lupescu of Bucharest writes and publishes a biological article in Rumanian, an English abstract will eventually appear in *Biological Abstracts* for the American scientist to see. However, knowledge of Dr. Lupescu's research will not be limited to American readers, but will accompany *Biological Abstracts* into 97 countries or principal dependencies of the world. As a result, Dr. Lupescu may one day be flattered but not unduly surprised to receive a letter regarding his research from Dr. Moto in Tokyo, Dr. Jones in Kenya, or Sr. Blanca in El Salvador.

How does the abstracting service make sure that Dr. Lupescu's article was "covered"? Although the method of abstract or title collection may differ in detail from service to service, I shall describe the situation at *Biological Abstracts.* First, *Biological Abstracts* publishes from time to time a list of the primary journals it is covering. As long as a primary journal remains on this list we have an abstracter assigned to it who undertakes to provide us with abstracts of all biological articles published in that journal. In order to publish 62,500 abstracts per year *Biological Abstracts* currently monitors more than 3700 periodicals originating in 83 countries and in 34 languages. (Among these will have been the journal in which Dr. Lupescu's article was published.) Although the major share of the abstracting of foreign language articles is done voluntarily by American biologists, we are very materially assisted by an additional 175 foreign biologists who serve as volunteer abstracters and who are located in 37 different countries (including Russia and mainland China.)

Having thus collected abstracts from the world's literature of biology our own editors arrange, classify and index the information for "secondary" publication. The next, and final, step is up to the individual scientist—be he American or foreign. It is now the responsibility of the individual to search the contents of the abstracting and indexing journal for the information he requires (if he does not find it, it very likely does not exist.) Those of us who are responsible for making scientific information available can so improve and modify our services that the individual scientist's search for information is made easier, but we cannot eliminate the search—we cannot spoon feed him. Indeed, it would be undesirable for us to do so even if it were possible. The search is his professional responsibility—and the new ideas that will occur to him during the search are his stimulation.

But this merely describes briefly the process of disseminating scientific information, it does not indicate how well we are covering the Russian and Chinese literatures of science. Since the Day of the Sputnik we have heard much of the Soviet All-Union Institute of Scientific and Technical Information and the 13 abstracting journals it publishes—more of this later. Abstracts of articles originating in the Soviet-bloc countries that are published in this series of abstracting journals are translated into English by the United States Joint Publications Research Service for distribution by the Office of Technical Services. Through the cooperation of these two federal agencies, the abstracting and indexing services of the United States are permitted to reprint these translated abstracts for direct dissemination to workers in their respective areas of science and technology. This comprehensive series of Russian abstract journals claims to cover a total of 4648 periodicals. Of this number, 1075 are Russian. Thus, if the average Russian scientist has access to an abstract of an article published in Russia, so potentially does our American scientist.

How good is our coverage of Chinese science? Table 2 shows the numbers and fields of Chinese scientific and technical journals that were published at one time or another during the period, 1905-1955. Mortality statistics regarding the birth and death of these periodicals is scanty and, until last year, we had but a poor idea of the current number that are being published. As was noted above, however, we have now learned from the Institute of Scientific Information of the Chinese Academy that at least 74 are in existence, of which 51% will be linguistically available to us, if and when we receive them. Over the past decade *Biological Abstracts* has from time to time obtained abstracts from 21 Chinese journals of biology, but it must be admitted that our coverage of the recent Chinese literature has been haphazard. Since the beginning of this year we have been taking steps to improve in this department and are hopeful that our correspondence with Peking will soon bring about a more direct flow of periodicals and abstracts. Actually, in the case of biology, this will mean the covering of only about 40 periodicals.

At this point it seems desirable to clarify this business of "translating." It is the experience of *Biological Abstracts*—and I believe that of most abstracting and indexing services—that it is best to read and understand a foreign language article and then write an abstract of it in English. That is what our foreign abstracters do. They do not write abstracts in a foreign language for us to translate. In our opinion this is a very great deficiency in our present wide coverage of Russian research—we feel strongly that proper abstract coverage can only be provided when American scientist-abstracters who understand Russian can read the "primary" article and then prepare an English-language abstract directly. To accomplish this desired end we are handicapped by the limited number of American scientists who can read Russian and thus serve as abstracters. It is far easier to obtain a large proportion of the Russian primary journals than it is to obtain abstracters in this country. I can suggest no ready solution to this problem.

Meanwhile, we have noted earlier the program of "cover-to-cover" translation of "primary" journals and the relative impossibility of handling the huge publication output of Russia in this fashion. It seems to me much more sensible to provide first an English abstract so that American scientists can judge the desirability of further detailed translation of the complete article. It should be pointed out and emphasized that not all reports of research are of equal importance or significance. Some may be relatively trivial reports giving more

detail about something already well known, whereas others will be reports of new discoveries or novel methods. Therefore, I would not increase substantially the present "cover-to-cover" system of translation, but would expand the selective translation of complete articles of significant interest as determined by review of abstracts by American scientists. For some years now, translations of specific articles have been registered and announced in a series of variously sponsored bulletins. These several bulletins have now in effect been consolidated in *Technical Translations*, a new publication of the Office of Technical Services. This is a service that should be strengthened and enlarged.

Table 3. Abstract and Citation Coverage Provided by Members of The National Federation of Science Abstracting and Indexing Services

Abstract Services	1957	1958	% Increase	1959	% Increase over 1957
Aero/Space Reviews	6,770	8,500	25%	12,000	77%
Applied Mechanics Reviews	4,245	5,285	24%	6,000	41%
Biological Abstracts	40,061	42,575	6%	62,500	56%
Chemical Abstracts	101,027	117,656	16%	130,000	29%
Engineering Index	26,300	30,000	14%	45,000	71%
Mathematical Reviews	9,200	9,000	(– 2%)	9,000	(– 2%)
Meteorological Abstracts	5,000	5,000	0%	7,500	50%
Nuclear Science Abstracts	14,042	18,000	28%	25,000	78%
Psychological Abstracts	9,074	6,100	(–33%)	12,000	32%
Review of Metal Literature	8,219	12,000	46%	12,000	46%
Technical Abstracts Bulletin (ASTIA)	4,276	30,000	601%	32,000	648%
U. S. Government Research Reports (OTS)	8,400	9,625	14%	10,000	19%
Technical Translations (OTS)	...	...	...	10,000	...
Sub-totals	236,614	293,741	24%	373,000	58%
Title Listing Services					
Bibliography of Agriculture	96,258	99,470	3%	100,000	4%
Current List of Medical Literature	104,517	114,214	9%	115,000	10%
Sub-totals	200,775	213,684	6%	215,000	7%
Grand Totals	437,389	507,425	16%	588,000	34%

In connection with a program of selective translation it becomes important to ensure easy access to any complete article to which the scientist has been introduced by an abstract. Having learned of an interesting article, the scientist must discover a library that receives the journal in which it appeared. If it is convenient he will go to that library; or, better, attempt to borrow the journal; or, better still, he will ask that a photocopy be made for his own use. For many years a photocopying service of this sort was provided many American scientists by the Department of Agriculture Library, but several years ago this was discontinued. The National Library of Medicine, I believe, provides such a service to other libraries who may request such copies for the use of their readers. Many private libraries offer photocopy facilities, but to provide truly comprehensive service the library must be a large, well-financed one whose collections can match the coverage of the abstracting and indexing services. There are very few that can provide such a service. *Biological Abstracts* has an arrangement with one of these, The John Crerar Library of Chicago. This library undertakes to provide for a very modest fee a copy of the complete text of virtually any journal article abstracted by BA. This is a link of great importance in the chain of scientific communication and it is one to which the National Science Foundation has given modest assistance through its support of the Midwest Interlibrary Center in the fields of biology and chemistry. The need exists, I believe, for similar regional centers elsewhere in the United States where essentially complete science journal collections can be housed and serviced. This is an important area for cultivation by the Foundation.

Table 4. Abstract and Citation Coverage Provided by the Soviet All-Union Institute of Scientific and Technical Information

	1957	1958	% Increase or (decrease)
1. Astronomy & Geodesy	10,000	7,902	(–21%)
2. Biology	103,445	113,375 (est.)	9%
3. Biochemistry	27,023	33,207	23%
4. Chemistry	79,039	84,041	6%
5. Electrical Engineering	45,206 (est.)*	45,206 (est.)†	...
6. Geography	27,601	30,197	9%
7. Geology	18,394	22,203	21%
8. Geophysics	10,750	9,650	(–10%)
9. Mechanical Engineering	53,450	53,450 (est.)†	...
10. Mathematics	9,035	10,925 (est.)	21%
11. Mechanics	13,649	15,105	11%
12. Metallurgy	25,562	25,579	no change
13. Physics	31,850	28,970	(– 9%)
Total	455,004	479,810	5%

*Final issues of 1957 will be published in 1959.
†The 1957 figures are used as estimates because so few 1958 issues have been received by libraries in the U. S.

Tables 3 and 4 are of considerable significance for they compare the major informational resources of the American and the Russian scientist. Although there are additional bibliographic services in both countries—and still more that are available in other English-speaking nations—those listed in Tables 3 and 4 are the largest and most comprehensive on both sides of the "linguistic curtain."

We are most proud of the growth in coverage provided by the members of the National Federation of Science Abstracting and Indexing Services. In 1959 we shall have increased our abstract coverage by 58% over that of 1957, and our total coverage by 34%. In comparison with the All-Union Institute we have now pulled ahead and our coverage in 1958 was 6% greater than that of Russia. Although it is too early to be sure, it looks as though we shall extend our lead in 1959.

American scientists can be sure that the abstracting and indexing services of the United States are providing them with as good and usually better coverage of the world's literature than is provided Russia's scientists by the All-Union Institute.

Analytical Methods in Applied Mechanics

(See also Revs. 5864, 5912, 6114, 6166, 6199, 6270)

Book—5853. Smirnov, W. L., Textbook in advanced mathematics [Lehrgang der höheren Matematik. Teil IV], Berlin, VEB Deutscher Verlag der Wissenschaften, 1958, xii + 708 pp. DM 40.

Translation of an extensive textbook on higher mathematics from the third Russian edition (second edition, see AMR **6** (1953), Rev. 11), which is intended mainly for students of mathematical physics. First chapter gives an outline of the theory of Fredholm's integral equations of the second kind, of some types of Volterra's equation of the first kind and of some of its generalizations. Second chapter on the calculus of variations is adapted mainly to applications in mechanics and contains a deduction of the different necessary conditions, an account of the geometric theory of extremals and some remarks on sufficient conditions. Theory is applied to many problems of mechanics and especially to theory of elasticity. Direct methods are briefly mentioned and their use is explained for two examples. Third chapter contains the general theory of partial differential equations. Equations of the first and second order and systems of such equations are treated. Among applications the theory of discontinuity propagation in ideal fluids and in elastic bodies is outlined. The last chapter contains the boundary-value theory for ordinary differential equations of the second and fourth order and deduces the most important general theorems on eigenvalues and eigenfunctions. Boundary-value problems for partial differential equations of elliptic, parabolic and hyperbolic type are also treated together with some applications to questions of elastostatics, wave propagation and heat conduction.

The matter treated is unusually ample for books of this kind, the exposition is clear and nearly all proofs are given in detail. There are some references to earlier volumes; but theorems on functional analysis, which forms the subject of the last (fifth) volume, are usually deduced. The German edition contains also some short explanatory notes, a list of authors cited and a bibliography with about 125 entries, restricted mainly to monographs and to a few more recent research papers.

A. A. Kuhelj, USA

Book—5854. Wayland, H., Differential equations applied in science and engineering, D. Van Nostrand Company, Inc., Princeton, N. J., 1957, xiii + 353 pp. $7.50.

After a short introductory chapter on the formulation of problems in engineering and physics by differential equations, illustrated by working out the derivation of the heat-flow equation in one dimension, the first major topic treated in Chapter II is vector algebra and vector analysis, with emphasis on the physical interpretation of such quantities as gradient, divergence and curl. Reasoning is sometimes intuitive, notation is that of Gibbs. Formulation of vector operations in general orthogonal curvilinear coordinates, of such importance in application to boundary-value problems is given in some detail, formulas for some special cases being given as problems and collected in a summary. There are some pages on formal ∇-calculus.

In Chapter III ordinary differential equations (mainly of the linear type) are treated with respect to classical methods of integration. Existence and uniqueness theorem for Cauchy's initial-value problem and representation theorem for the general solution of an inhomogeneous linear differential equation of order n are formulated without proof, but otherwise the presentation is self-contained. That the student is provided with different methods for constructing particular solutions of the inhomogeneous linear differential equation of order n is of great value. When investigating Duhamel's superposition integral there is a slight mistake, the stepfunction plotted in Fig. 3.6 not having just the discontinuity points used in the text.

Investigation of power series solutions of differential equations, given in Chapter IV, is confined to the discussion of second-order linear differential equations for which power series expansions of the solution about ordinary and about regular-singular points are fully described and illustrated by simple examples, expansions about irregular-singular points being only touched upon. The whole treatment is of mainly formal character. Some useful tests for convergence of general series, however, are collected (without proof) in a short final paragraph. When trying to illustrate "the character of the difficulty which arises when a series is not uniformly convergent throughout an interval" by the example of the series with partial sums $S_n(x) = nxe^{-nx^2}$ there is a regrettable omission on p. 152. The fact that "the magnitude of n required for a given upper limit on $S_n(x)$ is a function of x" is by no means characteristic for nonuniformity of convergence in the interval about the origin, the salient feature being that this $n(x)$ is unbounded in the neighborhood of the origin. Without stressing this point no thorough understanding of the concept of nonuniform (and uniform) convergence is reached.

Chapter V introduces some functions defined by linear differential equations of second order. Starting from separation of variables in Laplace's equation in cylindrical coordinates, Bessel functions and their modifications are studied and some physical problems giving rise to these functions (such as, for instance, the rotating chain, transverse vibrations of a heavy chain, vibrations of the clamped circular membrane) are discussed. Separation of Laplace's equation in three-dimensional polar coordinates leads via a family of spherical harmonics to Legendre functions. Some fundamental properties of the Legendre functions of integral order are treated. There is a useful summary collecting the more important formulas derived in the text or given in the problems.

Fourier series, the Fourier integral and orthogonal functions are the subject of Chapter VI. Fourier's theorem, giving a set of sufficient conditions under which a function can be expanded in a Fourier series, is formulated without proof, but some of the salient points regarding the meaning and application of this theorem are illustrated by means of examples. Gibbs' phenomenon is briefly sketched and Parseval's theorem is derived. Some remarks on harmonic analysis are made and two schemes for the approximate calculation of the lower harmonics are given. The problem of a square membrane clamped at the edges, of uniform density and uniform tension, is used to illustrate concept and use of Fourier double series. Fourier-Bessel series, as applied to a vibrating circular membrane clamped at the edge, and Fourier-Legendre series, as applied to the problem of steady-state temperature distribution in a homogeneous solid sphere, the upper and lower halves of which are held at different constant temperatures, provide the student with illustrations of the method of solving initial-value and boundary-value problems respectively, for linear second-order differential equations by expansions in series of orthogonal functions.

Drawing together the various techniques, Chapter VII gives a very instructive and agreeable reading on boundary-value problems in general. Mathematical models of a wide variety of physical content are used for illustration. Thus, e.g., the analogy between heat flow equation and diffusion equation is pointed out and the latter is applied to a problem of diffusion of moisture through a porous solid. Following V. H. Masket, linear diffusion is also used to give an elementary mathematical model of nuclear reactions, illustrating for the example of a slab reactor the concept of critical size by the possibility that, for suitable choice of the thickness of the slab, the lowest eigenvalue is independent of time, all others decreasing with increasing time. Finally, for several different physical problems the mathematical models are

set up leading to Laplace's equation (flow of incompressible fluids, electrostatics) or to wave equation (sound propagation, electromagnetic waves).

Chapter VIII, headed "Integral transforms," starts with the finite sine transform and the finite Hankel transform and gives a brief introduction to the Fourier and to the Laplace transform, just sufficient to make clear the meaning and technique of formal application of these concepts to differential equations.

The book has been prepared as a textbook for advanced undergraduates and beginning graduate students in applied science and engineering. Used concurrently with advanced courses in mechanics, electricity and magnetism, fluid mechanics, thermodynamics, it surely may be of great help for the student in grasping that part which is mathematics in his practical problems. But more than that, there is a continual endeavour by the author to provide the student with more than just mathematical techniques, trying to educate his critical mind as regards the relationship between physical reality and mathematical model.

There are over 325 problems, well spread over the book, a great many of them with answers. H. Behrbohm, Sweden

5855. Choudhury, P., On the effect of a certain type of nucleus of strain situated inside a semi-infinite aelotropic solid (in English), *J. Sci. Engng. Res., India* **1**, 2, 225–230, July 1957.

A Bessel function solution is given of stresses induced by a strain nucleus in a semi-infinite elastic body of transversely isotropic material. The nucleus is one that reduces to the center of dilatation in an isotropic body. D. Kececioglu, USA

Book—5856. Risser, R., and Traynard, C.-E., The principles of statistical mathematics, no. 4; (Statistical series, Book I) [Les Principes de la Statistique Mathematique, Fascicule IV (Series statistiques, Livre I)], 2nd rev. ed., Paris, Gauthier-Villars, 1957, xvi + 195 pp.

This is the first of two books of a two-book work on the principles of mathematical statistics. Reviewer feels that the authors have placed too much emphasis on the formal manipulatory aspects of statistics and too little emphasis on the key concepts and ideas. The material covered in the book gives little insight into or feeling for the great advances that have been made in statistics during the past two decades. The topics which are discussed no longer occupy the center of the stage. Almost nothing is said about statistics as a tool for the making of decisions. The point of view and scope of the book can be inferred from a free translation of the chapter headings: Chapter I: Classification. Arrangement of data into tables. Graphical presentation of data. Chapter II: Means and moments. Chapter III: Binomial distribution. Pearson's system of frequency curves. Various theoretical probability laws. Chapter IV: The decomposition of frequency distributions (into two or more components). Chapter V: Sampling. Estimation and testing hypotheses. Chapter VI: The problems of sampling (surveys) and quality control.

B. Epstein, USA

Book—5857. Risser, R., and Traynard, C.-E., The principals of statistical mathematics, no. 4; Correlations. (Time series, Book II) [Les principes de la statistique mathématique, Fascicule IV—Correlations. (Series chronologiques, Livre II)] 2nd rev. ed., Paris, Gauthier-Villars, 1958, xi + 418 pp.

This is the second book of a two-book treatment of the principles of mathematical statistics. The book is divided into three main parts:

Part I: Correlation, regression, various measures of correlation and dependence; statistical analysis of bivariate frequency tables; work of Gini, Jordan, Fréchet, and others.

Part II: Multivariate normal distribution, discussion of various total and partial coefficients of correlation; characterization of the multivariate normal and other multivariate distributions by appropriate partial differential equations; development of a system of probability surfaces. This is an attempt to introduce a classification of multivariate distributions by appropriate partial differential equations and surfaces.

Part III: Discrete and continuous time series; consideration of the autocorrelation function; periodogram and correlogram analysis; examples from economics, agriculture, and other applied areas; stationary processes, spectral analysis. While the first two chapters in part III are quite classical, the third chapter gives a good introduction to quite recent work by Bartlett, Karhunen, Grenander, and Rosenblatt on the statistical analysis of stationary time series. B. Epstein, USA

5858. Stephan, F. F., Two queues under preemptive priority with Poisson arrival and service rates, *J. Operat. Res. Soc. Amer.* **6**, 3, 399–418, May/June 1958.

This paper treats the problem of a preemptive priority system as a two-queue system in which both queues are serviced at the same center. Preemptive priority implies that if a higher priority item arrives while a lower priority unit is undergoing service, the lower priority unit will instanteously leave the service center. The distribution of service times is the same for all lower priority elements entering and re-entering service. The calculations are carried out for exponential holding times and Poisson arrivals of both classes of arrivals. The service characteristics of the priority units are the same as are obtained in the simple single-server queue system. The characteristics of the non-priority units are, of course, different. As an example, in comparing mean queue lengths, that of the higher priority queue is

$$\overline{m}_1 = \rho_1/(1-\rho_1)$$

while for the second queue,

$$\overline{m}_2 = [\rho_2/(1-\rho_1-\rho_2)][1+(\mu_2/\mu_1)\rho_1/(1-\rho_1)].$$

The method of solution random walk is to obtain state probabilities by considering the conditional probability that if the system is in the state (q, r) at time t_0, it will be in the state (i, j) at $t_0 + b(b \geq 0)$. The state probabilities are expressed in terms of the hypogeometric function. The procedure is quite elegant and worthy of careful study, particularly the use of moment generating functions to obtain the moments of waiting time, time in the system and units in the system. The results should be compared with those of White and Christie [*Operat. Res.* **6**, p. 79, 1958].

E. Koenigsberg, USA

Computing Methods and Computers

(See also Revs. 5892, 5898, 5960, 6043, 6116, 6281)

Book—5859. Booth, A. D., Automation and computing, 2nd ed., New York, The Macmillan Co., 1959, 158 pp. $5.

This is the first American edition of a survey-type work published in Great Britain last year. As the author states in the preface, "this book is an attempt to bridge the gap between the superficial accounts of electronic computers and automation which appear periodically and the specialist monographs which are now available."

The author covers a wide variety of topics. Besides the traditional chapter on history, three chapters are devoted to the logical design, physical design, and programming of digital computers. Following a chapter on analog computers, discussion is directed toward applications. Broad-brush coverage is given to automation in clerical work, control of continuous processes, automation of machine tools and assembly processes, strategic planning, and nonnumerical procedures.

The quality of coverage given the various topics varies considerably, as one would expect in a work of this broad nature. The

brevity of the book (only 152 pages) almost requires that some topics be given cursory attention. The chapters describing digital and analog computer characteristics, as well as those discussing machine tool and nonnumeric applications came closest to achieving the author's objective of being nonsuperficial. Many will find these instructive. On the other hand, the coverage of automation in plant and office may mislead the neophyte into believing that the author is serious in his inference that computers will replace mature judgment in decision making. It is comforting to note, however, that even the uninitiated will not likely be mislead by the author's irrelevant excursions into such topics as democracy, communism, man in decay, power in the hands of the unfit, and a short course in Malthusian doctrine. Without these extras, the topic of automation could become a trifle dull.

R. B. Grant, USA

5860. Dost, M., and Atkinson, C. P., Electronic computer simulation of a system with a "trilinear" restoring function, Proc. Third U. S. Nat. Congr. Appl. Mech., June 1958; Amer. Soc. Mech. Engrs., 1958, 133–140.

The differential equation, $\ddot{x} + c\dot{x} + f(x) = P \sin \Omega t$, has an odd, trilinear restoring function $f(x)$ that is alternately decreasing and increasing. Solutions were obtained by employing an electronic differential analyzer. Graphs, as produced by the computer, and response curves are presented for the resonance frequency ranges of the fundamental, second, and third harmonic. Two different kinds of jumps of the fundamental occurred: with negligible and with distinct phase change. Amplitude and phase jumps of superharmonics occurred simultaneously with smaller jumps of the fundamental. Two basically different configurations of the superharmonic components were found for the second and third harmonic.

From authors' summary

5861. Krishnamurthy, E. V., Lilavati—A new analogue computer for solving linear simultaneous equations and related problems, Part II: Design of model II and its application to the solution of secular equations, *Proc. Indian Acad. Sci.* (*A*) **48**, 5, 269–283, Nov. 1958.

This paper describes an analog computer for linear equations. Measurement of voltages is accomplished by potentiometric methods. Economy, accuracy, possible treatment of "secular" equations (eigenvalue problem) are indicated.

For Part I, see AMR **12** (1959), Rev. 2760.

J. M. Loeb, France

5862. Korthals Altes, J. P., Use of an electronic analogue computer with resistance network analogues, *Brit. J. Appl. Phys.* **10**, 4, 176–180, Apr. 1959.

Paper describes a method of solving partial differential equations of the elliptical type, with the aid of an electronic analogue computer in conjunction with a resistance network. Although this method is iterative the adjustments are made automatically by means of electronic memory elements and a switching mechanism. Some results are given.

In case the iteration process proves to be divergent an additional voltage source connected with a well-chosen node may offer a solution.

From author's summary

5863. Salzer, H. E., Formulae for hyperosculatory interpolation, direct and inverse, *Quart. J. Mech. Appl. Math.* **12**, 1, 100–110, Feb. 1959.

Paper gives coefficients to interpolate $f(x)$ when values are given for $f(x)$ and its first two derivatives at n equally spaced points, $n = 2(1)7$. Formulas are exact for polynomials of degree $3n - 1$ and are especially useful in connection with numerical solution of differential equations where pertinent values of $f(x)$, etc., are automatically available. Formulas for inverse interpolation are also given.

Y. L. Luke, USA

5864. Hyvarinen, L., Fourier analysis, a new numerical method, *Acta Polytech. Scandinavica* 248, MA 2, 19 pp., 1958.

To compute the coefficients of Fourier expansion of an experimental periodic function, use is made of Woodward's definitions of operators

$$\mathrm{rep}_t(f(x)) \equiv \sum_{\nu=-\infty}^{+\infty} f(x - \nu t)$$

$$\mathrm{comb}_t(f(x)) \equiv \sum_{\nu=-\infty}^{+\infty} f(\nu t)\, \delta(x - \nu t)$$

where $f(x)$ is a given function, t a constant parameter, δ the Dirac operator and ν any integer. We also will call a_n and b_n the usual coefficients of Fourier expansion. This leads to equations [16] involving a series of coefficients $a_n \; a_{5n} \; b_n \ldots$ which are computed by relaxation methods:

$$(16)\quad \begin{cases} \dfrac{1}{n\sqrt{3}} \displaystyle\sum_{\nu=-\infty}^{\infty} (-1)^{\nu} f_e\left(\frac{1-6\nu}{12n}\right) = a_n - a_{5n} - a_{7n} + a_{11n} + a_{13n} - \cdots \\ \dfrac{1}{n\sqrt{3}} \displaystyle\sum_{\nu=-\infty}^{\infty} (-1)^{\nu} f_0\left(\frac{1-3\nu}{6n}\right) = b_n - b_{5n} + b_{7n} - b_{11n} + b_{13n} - \cdots \end{cases}$$

f_e and f_0 even and odd components.

The principal point is that a suitable choice of sampling points eliminates unknowns such as $a_{n+1} \ldots$ A template is given that facilitates the determination of suitable sampling points. The coefficients a_n, $b_n \ldots$ are computed without actually performing integrations.

Author believes that the system can work if the series is sufficiently convergent, so that relaxation method is short enough. Understanding of the paper requires much labor that could have been spared by more detailed explanations.

J. M. Loeb, France

5865. Putnam, C. R., On the first stability interval of the Hill equation, *Quart. Appl. Math.* **16**, 4, 421–423 (Notes), Jan. 1959.

Author discusses "best possible" refinement to an estimate giving the right end-point of the first stability interval of the Hill equation.

G. Power, England

Analogies

(See also Revs. 5862, 6025)

Book—5866. Analogies in technology, Symposium of the Adriatic Electrical Society Conference, Venice, Oct. 1955. Vols. I and II [**I Modelli Nella Tecnica**], Rome, Italy, Accademia Nazionale dei Lincei, 1956; Vol. I, xxvii + 698 pp; Vol. II, 623 pp.

Experiments for research on models of various designs require the use of the laws of similitude. Application of these laws has many difficulties, especially the most obvious error of not taking account of all the possible factors which interfere in the perfect phenomenon to which the laws of similitude are applied.

From the first to the fourth of October 1957, a symposium on models was held in Venice on the occasion of the fiftieth anniversary of the Adriatic Electrical Society, under the auspices of the National Academy of Lincei. More than 150 representatives of different countries participated and about that same number submitted papers which were compiled into two precious volumes of the proceedings of the symposium.

There were seven sections of the symposium. In the first, models in hydraulics were under discussion. The second was subdivided into two parts in which models in aerodynamics and models in thermodynamics were the topics. Models of construction were

considered in the third section. In the fourth, acoustics and lighting were the subjects. Electrical models such as digital computers, antenna, etc., were the topic of section five. Included in section six were models in analogics, which refer to applied mechanics, elasticity, aerodynamics, the dynamics of nuclear reactors, etc. Considerations of technical economics were held in the last section.

Among the participants were many outstanding scientists who, with their presentations, indicated new directions for further research in theoretical as well as in practical applications. These papers appear in the two volumes, are completely illustrated with photographs, diagrams and tables, and include a bibliography, so that the reader can fully comprehend the progress which has been made toward the solution of these problems in various countries and the progress which is anticipated in the near future.

C. Papaioannou, Greece

5867. Hamilton, A. B., The use of an electrical model to analyze torsional vibration in a diesel engine, *GM Engng. J.* **5,** 4, 2-6, Oct.-Nov.-Dec. 1958.

5868. Gagarina, A. A., Application of electrical analogy to the calculations for a square plate with a square orifice (in Russian), Investigations on the theory of constructions, no. 7, Moscow, Gosstroiizdat, 1957, 533-547; *Ref. Zh. Mekh.* no. 5, 1958, Rev. 5690.

A description is given of the analogy between the plane problem in the theory of elasticity, to be solved by transpositions and the electric equivalent circuit. Assigning stresses to the modes of the chain (a potential) it is then possible to improve these values numerically; the process of improvement is the equivalent of the application of the method of successive approximations when solving a system of linear algebraical equations. This was the way an investigation was made of the problem on the plane stressed condition of a square ferroconcrete slab (320 × 320 cm) with a square opening (160 × 160 cm) subjected to even compression from two sides. The modulus of elasticity was taken to be 290,000 kg/cm^2, and Poisson's coefficient 0.167. The results of the numerical calculations arouse some doubts; for instance, the diagram of σ_x, which according to sections 2, 4, 6 should be self-balancing.

P. M. Varvak

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5869. Chegolin, P. M., Application of the method of electromechanical analogies for the solution of the problems of complex deflections of rod systems (in Russian), Electric modelling of beams and frameworks, Taganrog, 1956, 22-27; *Ref. Zh. Mekh.* no. 4, 1958, Rev. 4682.

It is shown that when making calculations for rods and beams under the action of simultaneously produced transverse and longitudinal forces it is possible to make use of their electrical models in the form of electrical tripole elements.

From author's summary

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5870. Foody, J. J., and Paul, R. J. A., Simulation techniques in aeronautics, *J. Roy. Aero. Soc.* **62,** 576, 878-892, Dec. 1958.

5871. Hacques, G., Calculation of the effect of conicity of an annular rotational wing in axial flow with help of the method of rheoelectric analogy (in French), *C. R. Acad. Sci., Paris* **245,** 18, 1510-1520, Oct. 1957.

5872. Loeb, A. M., The determination of the characteristics of hydrostatic bearing through the use of the electric analog field plotter, *ASLE Trans.* **1,** 1, 217-224, Apr. 1958.

Kinematics, Rigid Dynamics and Oscillations

(See also Revs. 5860, 5943, 5137, 6139, 6355, 6405, 6410)

5873. Liu, H.-C., Influence of the weight of the string upon the vertical falling motion of a pulley and stress in the string (in German), *Scientia Sinica* **8,** 1, 19-47, Jan. 1959.

The equation of motion of a pulley falling and unwinding a string is established by two methods, from the Lagrange equations of the problem and by treating it as a body with changing mass. The equation is solved in closed analytic form using elliptic functions and the solution is demonstrated to be physically meaningful. Expressions are obtained for the stress in the string, at the point of suspension and at the point of contact with the pulley. Special cases of the problem are discussed and extensive numerical results are displayed.

R. F. Drenick, USA

5874. Tartakovskii, V. A., and Gofman, S. I., Precision of the transmission by means of an elastic ribbon (in Russian), The theory and computations of the parts of appliances used in exact mechanics, Moscow-Leningrad, Mashgiz, 1957, 19-38; *Ref. Zh. Mekh.* no. 5, 1958, Rev. 5021.

An investigation is made of the transmission by a rotating untensioned ribbon through a pulley with radius R between two parallel rollers. A theoretical analysis is carried out regarding the influence of elasticity during the deflection of the ribbon on the change in magnitude of angle δ, the angle of lag between the driven roller and the driving, in consequence of the increase of force P, tensioning the ribbon in proportion to the increase of resistance of the driven roller. An approximate formula was obtained

$$\delta = \frac{\sqrt{(EI)^3}}{6R^3}\left(\frac{1}{\sqrt{P_2^3}} - \frac{1}{\sqrt{P_1^3}}\right)$$

and it was shown that the error in calculations by this formula does not exceed 2×10^{-13} when the usual practical steps were taken regarding the precise construction of the parameters of the transmission in the apparatus used. A reference is made to the satisfactory agreement of the theoretical and experimental data obtained when testing appliances with this type of transmission.

M. K. Kristi

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5875. Hatano, T., An examination of the rocking phenomenon (in Japanese), *Trans. Japan Soc. Civ. Engrs.* no. 62, 6-15, May 1959.

The reduction of velocity in the free rocking motion of a rigid body on a rigid base has been hitherto explained on the basis of constant angular momentum. According to this theory, an abrupt reduction of velocity, in other words energy of motion, is justifiable when the rigid body falls down on the base, even in the ideal case neglecting energy consumption.

This paper reports observations and considerations on the free rocking of the graphite prisms on various bases, and it has been clarified that the application of the law of constant angular momentum is not suitable and the reduction of energy must be explained by sliding, elasticity, sound or otherwise.

From author's summary

Courtesy, Editorial Committee of the Japan Society of Civil Engineers

5876. Oertel, G. K., and Singer, S. F., Some aspects of a three-body problem, AFOSR TN 59-405 (Air Force Office of Scientific Research; ASTIA AD 214 502), 21 pp., Mar. 1959.

Authors treat a special case of the restricted three-body problem of celestial mechanics, namely the motion of a particle in the

field of two nonrotating mass centers whose separation remains fixed. Applying a formalism developed by Charlier they derive limits for the motion of this small mass and give, in particular, the equations for the ellipses in terms of the constants of motion. Especially simple expressions have been derived for a particular choice of initial conditions. Interestingly, the equations of the two limiting ellipses do not depend on how the total mass is distributed between the two centers of attraction; they depend only on the separation of the two centers. However, the rate at which the actual orbit traverses between the limiting ellipses does depend on the division of the mass. For the case in which the two limiting ellipses coincide, the periodic case, the energy and also the equation of the orbit are independent of the distribution of the total mass between the two centers, the energy being the Kepler energy for the particular orbit.

The theory may be applied to discuss the motion of a satellite near a planet which has a large bulge or "bump."

From authors' summary

5877. Valentine, F. A., The motion of a flexible inelastic tube constrained to move on a rough convex curve, *Amer. Math. Monthly* **65,** 3, 179–184, Mar. 1958.

5878. Glushchenko, I. P., The dynamics of setting transmissions in motion by means of a flexible connection (in Russian), Some problems in the dynamics of mechanics, L'vov In-ta, 1956, 31–41; *Ref. Zh. Mekh.* no. 5, 1958, Rev. 5019.

For the initial stage of starting—when the driving shaft is moving, while the driven shaft had not yet moved—an approximate differential equation is derived and is then integrated in quadratics. As the result of the integration the initial values for the second stage of starting are obtained; here, both the shafts are in motion. For the second stage, linearized equations are derived, and on their bases approximate values for the dynamic pull on the driving link of the transmission are computed.

S. G. Kislitsyn

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5879. Simanovich, A. V., Some questions relating to the flexible links with the spindles of spinning machines (in Russian), *Nauchn. Issled. Tr. Kostromsk. Tekst. In-ta* no. 9, 140–145, 1955; *Ref. Zh. Mekh.* no. 5, 1958, Rev. 5020.

Paper is an attempt to improve the calculations for the transmission by means of a flexible link. A. S. Petrov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5880. Vorob'ev, L. N., Determination of the transposition of points in deforming systems (in Russian), *Nauchn. Trudi Novocherk. Politekhn. In-ta* **29,** 43, 3–24, 1955; *Ref. Zh. Mekh.* no. 5, 1958, Rev. 5675.

In order to determine the end transposition of points in deforming systems the proposition is made to use the equation of quasivirtual work. In its application to the system of discrete material points this equation is obtained by summing up the equations of equilibrium of each small portion of the system, preliminarily multiplied scalarly on the arbitrary transpositions. The evaluation by the author of the different conditions of equilibrium calls for comment. For instance, Eqs. [2.1] and [2.3] differ only as regards symbols, while the parts they play are said to be very significantly different. As regards the formulation of the conditions of equilibrium of a continuous body, the author is wrong in emphasizing the existence of six equations for the equilibrium of the body's elements, for it is quite clear that the condition of the equality to zero of the principal moment of all the forces acting on the element leads to the same result, as the stressed condition of the body in the point is determined by the tensor and not the affinor. Author did not notice this because of his unsuccessful selection of stress components. Investigations are made, on doubtful premises, regarding simplification of the equations for quasivirtual work, mainly to study rod deformations on the basis of the hypothesis of plane sections. L. A. Tolokonnikov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5881. Epstein, M. O., The dynamic rigidity of a vertical shaft (in Russian), *Trudi Leningr. In-ta Aviats. Priborostr.* no. 14, 33–45, 1956; *Ref. Zh. Mekh.* no. 2, 1958, Rev. 2119.

A characteristic equation is set up for determining the critical angular velocity of a vertical shaft carrying a single, attached disk. The analysis makes allowance for the gyroscopic effect and the influence of the weight of the disk but neglects the mass of the shaft and the influence of the direction of rotation of the bent (deflected) axis of the shaft. An analysis of the characteristic equation for particular cases is given. I. E. Shashkov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5882. Heinz, E., Simplified deflection calculations by virtual work, *Civ. Engng., N. Y.* **28,** 11, 73–74 (Engineers' Notebook), Nov. 1958.

5883. Vorob'ev, Yu. V., Method of moments in the problem on the vibrations of linear systems (in Russian), *Vychisht. Matematika* no. 1, 23–33, 1957; *Ref. Zh. Mekh.* no. 5, 1958, Rev. 4977.

An investigation is made of the problem of a system of ordinary linear differential equations of a high order, with constant coefficients, when algebraical methods are no longer effective, and, in conjunction with this, the problem also of the approximate substitution-solution of the given system by another, close to it, but of a lower order. The equation is examined

$$\frac{\partial x}{\partial t} = Ax + gf(t) \qquad [1]$$

where $gf(t)$ is the compiling force, A is the delimited linear operator, determined in the whole Gilbert region H. For the solution of Eq. [1] use is made of the author's method of moments, ["Successes of math. science," *Uspekhi Matem. Nauk*, **9,** 1, p. 59, 1954]. In conformity with that method a series of iterations is derived

$$z_0 = g,\ z_1 = Az_0,\ \ldots,\ z_n = A^n z_0,\ \ldots$$

after which Eq. [1] is replaced by an equation close to it

$$\frac{\partial x_n}{\partial t} = B_n x_n + gf(t) \qquad [2]$$

the solution of which is sought in the form of a series

$$x_n = \eta_0(t)z_0 + \eta_1(t)z_1 + \ldots + \eta_{n-1}(t)z_{n-1} \qquad [3]$$

Replacing [2] by [3] and equalizing the coefficients with z_i author obtains a system of equations equivalent to the operating equation [2]

$$\begin{aligned}
&\frac{\partial \eta_0}{\partial t} + \alpha_n \eta_{n-1} = f(t)\\
&\frac{\partial \eta_1}{\partial t} - \eta_0 + \alpha_{n-1}\eta_{n-1} = 0\\
&\cdots\cdots\cdots\cdots\cdots\cdots\\
&\frac{\partial \eta_{n-1}}{\partial t} - \eta_{n-2} + \alpha_1 \eta_{n-1} = 0
\end{aligned} \qquad [4]$$

The system obtained is easily solved by means of Laplace's conversion, when, in so doing, the customary system [1] can be replaced by system [4] of a lower order. When making this substitu-

tion an evaluation of the extent of error is carried out and it is shown that the error will be small if some of the natural vibrations are feebly excited. Yu. A. Mitropol'skii

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

Book—5884. MacDuff, J. N., and Curreri, J. R., Vibration control, New York, McGraw-Hill Book Co., Inc., 1958, vii + 465 pp. $9.

Book represents an extensive introduction to modern vibration theory and concerns mostly systems with one degree of freedom. The first four chapters deal with a steady-state response of systems describable by linear differential equations with constant coefficients; the end of Chapter 4 deals also with some nonlinear features; the use of the phase plane method is also explained in connection with some numerical problems. In Chapter 5 are indicated the various methods for the determination of natural frequencies. Chapter 6 is devoted to problems of isolation of steady-state vibrations; this chapter presents a considerable amount of experimental material. In Chapter 7 authors give a survey of mechanical transients; the use of Laplace transformations and other operational procedures is explained and illustrated with a number of numerical examples. Chapters 8, 9 and 10, deal with the principal vibration problems: of balancing, of lateral vibration of shafts and of torsional vibrations, respectively. In Chapter 11 some threshold acoustical problems of sound and noise are studied. Chapter 12, the last, gives a short outline of the theory of automatic control systems.

The book presents a good balance between the theory and experimental results; likewise, a reasonable proportion is kept between the classical concepts and procedures on one hand and some of more recent developments on the other. The book is written in a rather elementary manner.

N. Minorsky, Italy

5885. Volterra, E., Recent applications of the method of internal constraints to dynamic problems (in Italian), *G. Gen. Civ.* **96,** 7/8, 39 pp., July/Aug. 1958.

Paper presents an approximate method for vibration study of straight and curved beams, cylindrical shells and rectangular and circular plates. Derivation is based on assuming hypothetical related displacements or internal constraints between points during movement; equations of motion are obtained by imposing Hamilton principle to potential and kinetic energies which are determined, in each case, departing from expressions including unknown functions for displacements. Thus, first, author resorts to Navier assumption and deduces corresponding solutions for beams, shells and plates. Secondly, mentioned solutions are improved by adding second-order terms to previous assumed displacements. Finally, last deduced equations are applied to wave propagation in beams and also to free and forced vibrations of straight beams of finite length. Graphs illustrating author's solutions agree well with known results. H. C. Reggini, Argentina

5886. Cannon, R. H., Jr., Vibration analysis by the root locus method, Proc. Third U. S. Nat. Congr. Appl. Mech., June 1958; Amer. Soc. Mech. Engrs., 1958, 95–100.

Using a semigraphical method for finding roots of the pertinent algebraic equation, plots are obtained for the system characteristics, i.e. frequency and rate of decay for systems of masses, springs and dashpots. Similarly, system frequency response may be obtained. Conventional algebraic attack would yield same results with no greater expenditure of time, but author's method may sometimes be convenient for seeing effect of varying system parameters. F. L. Dimaggio, USA

5887. Scholz, H., The Krylov-Bogolyubov method for solving nonlinear vibrational problems (in German), *Öst. Ing.-Arch.* **12,** 1/2, 47–59, Nov. 1958.

Author treats equation $\ddot{q} + \nu^2 q + \varepsilon f(q, \dot{q}) = 0$ by K – B method, taking $f(q, \dot{q})$ as a polynomial in q and $\dot{q}$. First approximation is obtained explicitly for fifth power odd-order polynomial; higher approximations are transcendental. Method is illustrated on Van der Pol and other nonlinear equations. Comparison with exact elliptic integral solution of $\ddot{q} + q + \varepsilon q^3 = 0$ shows very good agreement. Paper has excellent references to recent German work.

V. Salmon, USA

Book—5888. Bogolyubov, N. P., and Mitropolskii, Yu. A., Asymptotic methods in the theory of nonlinear oscillation (in Russian), Moscow, Gostekhizdat, 1955, 447 pp. 13r 40k; *Ref. Zh. Mekh.* no. 2, 1958, Rev. 1583.

Instrumentation and Automatic Control

(See also Revs. 5859, 5860, 6303, 6304, 6358)

Book—5889. Solodownikow, W. W., Fundamentals of automatic control, Vol. I: General considerations on the theory of linearized automatic control systems [Grundlagen der selbsttatigen Regelung, Band I: Allgemeine Grundlagen der Theorie linearisierter selsttatiger Regelungssysteme], (Translated to German from Russian), München, R. Oldenbourg Verlag, GMBH, 1959, xvi + 727 pp. DM 65.

This work contains a fairly complete description of mathematical, numerical and graphical methods for the analysis, synthesis, and optimization of linear, lumped parameter, control systems. Experimental and analog methods are not discussed. The book is a translation of a Russian text for a graduate engineering seminar. Methods are carefully explained mainly by means of nontrivial illustrative examples. Many references are given to Russian papers and texts, some of these being translations of western works; translator has added some German references. Sketches are given of existing control systems such as those for a universal milling machine, turbogenerator, and autopilot.

The volume is divided into four sections, each containing several chapters, with many subsections. The table of contents is therefore a fair subject index for the volume. The actual subject index and indeed certain needed tables appear only at the end of the second volume. References are given at the end of each section.

Section I opens with a short historical survey of Russian contributions to control science. There follow sections on definitions of terms, mainly by example, and descriptions of typical control elements. The derivation of the equations of motion for simple mechanical systems by the method of Lagrange is described and their linearization in the case of small motions around equilibrium discussed. Useful facts from Fourier and Laplace transform theory are given and their consequences for control design discussed. Transfer and step-response functions are defined and relations between their analytic properties and the motions of the controlled elements described. The chapter ends with descriptions of useful elementary parts of control systems, their operator characterizations, and their integration into complex systems.

Section II treats stability questions. It begins with the universally valid definitions of Lyapunov and a description of his two main methods. Consequences of these definitions for transfer and response functions are explored. Stability criteria of Routh-Hurwitz and Nyquist are presented. Usefulness of logarithmic amplitude and phase plots is explained. Extension of the methods to systems with delayed response is given as an application to systems with distributed parameters.

Section III discusses optimization of system behavior both by exact and approximate methods. Algebraic and integral criteria of optimality are described and their uses explained. The addition

of feedback loops for the improvement of system performance is discussed. A final section discusses on-off controls.

Section IV concerns the operation of control systems subject to random forcing function. Subsections treat design for desired statistical properties of the output from the known properties of the input. C. M. Ablow, USA

Book—5890. Solodownikow, W. W., Fundamentals of automatic control, Vol. 2, Some problems from the theory of nonlinear control systems [Grundlagen der selbsttatigen Regelung. Band II. Einige Probleme aus der Theorie der nichtlinearen Regelungssysteme], (Translated from Russian), Munchen, R. Oldenbourg Verlag, GMBH, 1959, viii + 449 pp. DM 52.

This second volume contains descriptions of mathematical methods for the analysis of nonlinear lumped parameter control systems. Since no complete theory is available, attention is directed toward practically useful analytic devices in their application to typical nonlinear problems.

In section V, major types of nonlinearity, such as Coulomb friction, backlash, and hysteresis, are exhibited and their equations derived. Phase plane methods are described. Methods for the improvement of the dynamic properties of systems by the introduction of nonlinearities are exemplified.

In section VI the determination of amplitude, frequency, and stability of autonomous oscillations by small parameter and perturbation methods is described. Section VII contains application of theory to relay systems. Section VIII contains graphical methods for the integration of linear or nonlinear ordinary differential equations.

The two volumes of this work give a broad survey of practical methods for the analysis and design of control systems with numerous worked out examples, useful theoretical curves and nomograms. Each section and each chapter begins with introductory paragraphs describing the material to follow. The large bibliography contains a world coverage of relevant books and papers, mostly published before 1952. Subject and author indices for both volumes are given. The typography and binding are excellent, the paper of high quality.

The two volumes form an excellent text and reference on mathematical methods. The many worked examples and detailed explanations are most helpful. An objection to the exposition is that theorems are not rigorously stated so that the limits of applicability of a method are not clear. C. M. Ablow, USA

Book—5891. Ledgerwood, B. K., edited by, Control engineering manual, New York, McGraw-Hill Book Co., 1957, viii + 189 pp. $7.50.

Title and Subtitle, "A guide to the practice of control system engineering," seem somewhat too promising. Editor has assembled a number of papers which have been published in earlier issues of *Control Engineering*. These papers are combined into groups in a very systematic way, viz. the practical design of control systems, including such headings as specifying, synthesizing and evaluating control systems and the available special tools, such as generating control functions, design techniques, a c analog computers, nonlinearities and basic literature. Main feature of the book is that it presents in a neat and convenient way much of the pertinent information which has appeared in the aforementioned periodical. R. G. Boiten, Holland

5892. Marcus, S. C., How to keep track of system errors, *Control Engng.* **6,** 3, 114–115, Mar. 1959.

Attaining overall system accuracy is one phase of systems engineering too often pursued in haphazard fashion. In this article, author advocates an orderly and logical procedure for keeping an up-to-date account of permissible and actual errors anywhere in the system. With integrated system error analysis, the author contends, the system designer can make realistic initial assignment of subsystem and component tolerances, and modify them from time to time as indicated by technical and economic considerations.

From author's summary

5893. Sokolov, N. I., Approximate analytical method for calculations for transition processes in linear systems of automatic control (in Russian), *Trudi Mosk. Aviats. In-ta* no. 75, 73–102, 1957; *Ref. Zh. Mekh.* no. 5, 1958, Rev. 4994.

Using the known Laplace conversion for the end magnitudes, an approximate method for calculating the transition processes in systems of automatic control is looked into; this avoids the necessity to know the roots of the characteristic equation. The transition processes during disturbance are calculated in the form of triangular and rectangular impulses of one height, and also of a triangular impulse of unit area. Some recommendations are made regarding the selection of the stage of integration. A method is also examined for the calculation of transition processes in systems of automatic control by adopting known transition processes of individual links, obtained experimentally or calculated analytically. The margin of error in the calculations is evaluated.

E. P. Popov

Courtesy Referativnyi Zhurnal, USSR

Translation, courtesy Ministry of Supply, England

5894. Sokolov, N. I., Application of transmission functions and reverse transition functions, expressed in trigonometrical form, for the calculation of systems of automatic control (in Russian), *Trudi Mosk. Aviats. In-ta* no. 75, 26–39, 1957; *Ref. Zh. Mekh.* no. 5, 1958, Rev. 4996.

An examination is made of the customary amplitudinal phase-characteristics of the links and closed systems with the only difference that instead of recording the modulus in the usual form of

$$\frac{1}{\sqrt{T^2\omega^2 + 1}}$$

$\cos \alpha$ is used, where $\alpha = \text{arc tg } T\omega$. E. P. Popov

Courtesy Referativnyi Zhurnal, USSR

Translation, courtesy Ministry of Supply, England

5895. Chernov, E. I., Application of the theorem of parcelling to the analysis of systems of automatic control with variable coefficients (in Russian), Transactions of the second Soviet conference on the theory of automatic control; Moscow-Leningrad, Izd-vo Akad. Nauk SSSR, 1955; **2,** 386–398, 399–400; *Ref. Zh. Mekh.* no. 5, 1958, Rev. 5001.

It was shown that the parcelling method is a generalized method of successive approximations; the advantages of this method by comparison with the method of series are indicated; the former does not demand knowledge of the numerical values of the coefficients of the equation and opens up the possibility of deriving a solution in a general form. The method proposed by the author, in common with the method of series, is unwieldy and laborious if a great degree of accuracy is to be attained. The Zade and Kirby methods are demonstrated, these being used for the solution of differential equations with variable coefficients; the deficiencies in the Zade method are pointed out, as also the deficiencies and advantages of the Kirby method and of the method adopted by the author. There are misprints. A. S. Tkachenko

Courtesy Referativnyi Zhurnal, USSR

Translation, courtesy Ministry of Supply, England

5896. Sundstrom, N., and Flodin, K., On the use of spectral densities in the study of servo circuits defined by linear differential equations with time-variable coefficients and stochastic right member (in English), Kungl. Tekn. Hogskol. Handl., no. 44, 9 pp., 1957.

If a servo is defined by a system of linear differential equations with constant coefficients, it is well known how to derive spectral densities of outputs from those of inputs. Paper purports to extend this method to apply to more general case of time-varying coefficients.

Problem is reduced to a set of simultaneous linear integral equations, but no solution is derived. Indeed, the integral equations are equivalent to original differential equations, therefore, problem is not solved unless differential equations can be solved. In this case, however, reviewer believes it is obvious how solution can be found, since equations can be solved for outputs as functionals of inputs, and mathematical expression for spectral density can then be found and evaluated. M. Shinbrot, USA

5897. Ershov, B. A., Method for evaluations in investigations of the stability of nonlinear control systems (in Russian), *Uch. Zap. LGU* no. 217, 22-27, 1957; *Ref. Zh. Mekh.* no. 5, 1958, Rev. 4969.

A differential equation of the following form is investigated

$$\frac{dX}{dt} = AX + F(X), \qquad X(0) = X_0$$

$$F(X) = \begin{Vmatrix} b_1 f(x_1, \ldots, x_n) \\ \ldots\ldots\ldots\ldots \\ b_n f(x_1, \ldots, x_n) \end{Vmatrix} \qquad [1]$$

This describes the disturbed motion of a controlled system where X is the matrix column, A the quadratic constant matrix, $F(X)$ the matrix column, b_i are constants. The function $f(x_1, \ldots, x_n)$ satisfies the conditions for the theorem of existence and uniqueness of the solutions of the given equations and, besides,

$$|f(x_1, \ldots, x_n)| \leq \alpha \sum_{i=1}^{n} |x_i| \qquad [2]$$

$$f(0) = 0, \qquad \alpha > 0$$

Relying on the integral equation, the equivalent of equation [1], author develops a method for obtaining an evaluation for matrix $\|X\|$. From the evaluation is deduced the asymptotic stability with $\alpha\gamma < \lambda$, when λ are the natural values for A, and when γ is determined by means of the coefficients of A. I. Lur'e's canonical conversion. A. M. Letov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5898. Kotelnikow, W. A., Use of memory device to improve the stabilization of automatic-regulation systems with limited servo motor speed (in German), *Regelungstech.* **6**, 8, 287-294, Aug. 1958.

(Note: This is a translation of an article from *Avtomatika i Telemekhanika* **18**, 4, 289-303, 1957. An English translation of the same article appears in the corresponding number of *Automation and Remote Control* in English translation, pp. 321-334.)

The problem of designing a stable automatic-regulation system is considered under conditions of limited drive speed and unlimited initial errors.

A memory and switching device, satisfying the above requirements in the presence of a regulator with proportional feedback, is developed. The stability limits, which serve as a basis for determining the permissible values of regulator parameters, are determined for automatic-regulation systems with such a memory device. Analog methods are used to determine the transients in the automatic-regulation systems when the errors exceed the linear speed range of the regulator drive.

From author's summary by T. P. Goodman, USA

Book—5899. Eckman, D. P., Automatic process control, New York, John Wiley & Sons, Inc., 1958, vii + 368 pp. $9.

Book is intended as a first text on automatic control, as applied to processes, for undergraduate engineering students. The transient response approach is used exclusively in Chapters 1 through 8 (The science of automatic control; Process characteristics; Controller characteristics; Closed loop in automatic control; Measuring elements; Controlling elements; Final control elements; Process instrumentation). The differential operator d/dt and block diagram manipulations are employed in deriving system differential equations. Only lower-order systems are considered since the complexity of solving higher-order differential equations in the time domain by classical methods rapidly gets out of hand. In Chapters 9 and 10 (Sinusoidal analysis; Stability analysis) the frequency-response approach is covered briefly with a marked lack of rigor. Essentially, in these two chapters, author outlines the frequency-response approach without presenting very much of the theory underlying it and without seriously applying it to the study of the controlled process.

In the reviewer's opinion it would have been far better if the earlier chapters on the dynamics of the controlled process had been developed using the frequency-response approach. In this manner the student would gain much greater insight into the subject matter since output response and system parameters would be more clearly related than they are in the transient-response approach. Also, problems of a more sophisticated nature could be treated. The order in which the chapters are read may be changed, as the author suggests in his preface, but this will not alter the manner in which the material is already developed. The examples, problems, and suggested experiments in the text are all drawn from process control and constitute the only recommendation for the book. It should be noted that there are numerous errors throughout the text. For a first course in automatic control of processes, the student would be well advised to turn instead to one of the many excellent elementary texts on servomechanisms now available, using this text only for its examples and problems in process control and its descriptive material concerning components.

S. Z. Dushkes, USA

Book—5900. Campbell, D. P., Process dynamics—dynamic behavior of the production process, New York, John Wiley & Sons, Inc., 1958, xix + 316 pp. $10.50.

The book contains a comprehensive treatment of the dynamic behavior of the most important elementary processes applied in process industry. On the basis of the fundamental physical and chemical laws, the mathematical equations describing the different systems—in general differential equations—are established. Dynamic behavior is characterized and discussed in terms of transfer functions, transient or frequency response. Where it is of particular interest, also the closed control loops are analyzed for different types of controllers.

In Chapter 1, the kinematics of material handling are presented. Flow and storage of materials and their regulation are dealt with. Transportation lag and its effect on control are discussed. Mixing and quality control are analyzed.

In Chapter 2, the dynamic behavior of fluid in motion is treated. The regulation of liquid level is dealt with as well as the control of pressure and flow for incompressible and compressible fluid. Network aspects of fluid-handling systems are demonstrated.

In Chapter 3, control problems of forming, propulsion and guidance are presented.

Very complete treatment of thermal process dynamics is given in Chapter 4. The fundamental equations for the most important types of heat exchangers as well as the transfer functions for some practically interesting cases are developed.

In the last two chapters, mass transfer and chemical process dynamics are treated with special reference to problems related to

distillation, chemical reaction control, and composition regulation.

The book is not written for beginners. The reader is expected to have some knowledge of differential equations and Laplace transformations, and he should be familiar with the principles of automatic control. The book is, in concentrated form, an excellent survey of the broad field of process control. Reviewer feels it should be in the library of every process control engineer.

P. Profos, Switzerland

5901. Davydov, N. I., Dudnikova, I. P., Dudnikov, S. G., and Mel'nikov, B. N., A method for determining the frequency characteristics of industrial items in control systems (in Russian), *Teploenergetika* no. 9, 35-42, 1956; *Ref. Zh. Mekh.* no. 5, 1958, Rev. 5003.

The basic effects encountered in the experimental determinations of the frequency characteristics of industrial items by the method of the "rectangular wave" are noted. An experimental method is proposed for the determination of the frequency characteristics of items, based on the excitation of harmonic vibrations in a closed system of control by means of supplying sinusoidal reactions to the inlet of the regulator, the supply being obtained from a special generator of sinusoidal vibrations. A standard type of induction transmitter made by the "Energopribor" works was used, the plunger of which was brought into a reciprocal motion by means of a Warren motor. Change of frequencies was effected by altering the gear ratio. The recording of the outgoing vibrations was performed by an electronic automatic potentiometer type EPP-09. A graphical method is proposed for the isolation of the basic harmonic from the recorded curve. An example is given for the determination of the dynamic characteristics of a continuously operating coil boiler type 51SP 230/100. A. A. Voronov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5902. Profos, P., Dynamics of superheater control (in German), *Regelungstech.* **6**, 7, 239-246, July 1958.

The exit temperature from steam superheaters may be controlled by a variety of schemes in most of which the final control element manipulates the inlet temperature, the heat input and the steam flow, either singly or in combination. Approximate transfer functions for changes in exit temperature versus changes in each of the above three variables are shown in terms of heat-transfer coefficients, equipment dimensions, heat capacities and the Laplace variable. The system response to various disturbances is discussed for different methods of control, both with pure feedback and with feedback and feedforward loops. Block diagrams and abbreviated transfer functions are given. Disturbances originating at the steam boiler are examined in some detail. The closed-loop transfer functions are so complicated even in the simpler cases that a detailed evaluation of the frequency and transient response for practical design studies could not be undertaken without the use of high-speed computing devices.

A. W. Gessner, USA

5903. Friedman, G. J., Frequency response analysis of the vane-type angle of attack transducer, *Aero/Space Engng.* **18**, 3, 69-75, Mar. 1959.

The frequency response characteristics of a vane-type angle-of-attack transducer are quite different from those of the classical vibration system, and the usual curves of amplitude, damping, frequency, and phase lag do not apply.

From author's summary

5904. Kohr, R. H., The application of mathematics to a basic study of automobile control and stability problems, *GM Engng. J.* **6**, 2, 14-19, Apr./May/June 1959.

Deviation of an automobile from a straight-ahead course is called lateral response, which can take the form of three lateral motions: yaw, roll, or sideslip. A study of dynamic lateral response of an automobile to predict its reaction to steering wheel displacements has always been difficult, due to lengthy and involved mathematical computations required in vehicular analysis work. The advent of analog and digital computers, however, has served to lessen the complexity of such a dynamic study. Recently, the GM Research Laboratories undertook a basic study of automobile control and stability problems. Three simultaneous, linear differential equations were developed which described the three lateral motions of an automobile. Included in the three equations were 20 variables each of which had a particular effect on control and stability. Once the equations had been verified, computers were then used to analyze the control and stability performance of a car as it would be affected by each of the variables. The results of this program, which represents but a first step in an overall systems analysis of a general automobile steering study, have provided a basic understanding of the effects of various parameters on the dynamic lateral response of an automobile.

From author's summary

5905. Carroll, J., Interplanetary navigation by optical resection and inertial systems, *Aero/Space Engng.* **18**, 3, 53-55, Mar. 1959.

Some functional aspects and limitations of the instrumentation of a combined optical-inertial system for navigation in nearby interplanetary space are presented. The interplanetary space considered here is limited to those regions in the solar system where the visibility of the illuminated disks of nearby planets is acceptable for optical tracking purposes.

From author's summary

5906. Ivanov, Ya. A., Some questions on the theory of gyroscopic devices for the creation of induced rolling of ships' models (in Russian), *Trudi Leningrad Korablestroit. In-ta* no. 18, 125-139, 1956; *Ref. Zh. Mekh.* no. 5, 1958, Rev. 5388.

This is a theoretical investigation of some gyroscopically actuated rocking devices, for use when studying rolling in tanks instead of by artificially created waves on the water's surface. An analysis of the usual equations for the theory of gyroscopes led to the following deductions: (1) Single-rotor devices create simultaneously rolling and pitching or rolling and yawing. (2) The amplitude of the disturbing moment varies in the case of single-rotor devices in relation to the pitching, yawing and the frequency of the rolling. (3) A two-rotor device with swivelling axes for the rotors is free from these defects and can be safely recommended for investigations of rolling in tanks. S. V. Zhak

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

Tables, Charts, Dictionaries, etc.

Book—5907. Gaynor, F., Concise dictionary of science; Physics, mathematics, nucleonics, astronomy and chemistry, New York, Philosophical Library, 1959, 546 pp. (5000+ entries) $10.

This up-to-date dictionary provides concise definitions on terms and concepts pertaining to all fields of science. Full coverage is given to the newer sciences of virology, enzymology, cytogenetics, radio-chemistry, high energy, solid-state physics, etc.

Ed.

Book—5908. Condoyannis, G. E., Scientific Russian—a concise description of the structural elements of scientific and technical Russian, New York, John Wiley & Sons, Inc., 1959, xii + 225 pp. $3.50.

This book is intended to fill a need not ordinarily met by elementary language textbooks.... It is meant primarily for beginners with no previous knowledge of Russian, but can also be used by those who wish to refresh their knowledge of the language. It can be used in classes or for individual study.

From author's preface

Book—5909. A phrase and sentence dictionary of spoken Russian, New York, Dover Publications, Inc., 1958, vi + 573 pp. $2.75. (Paperbound)

This new edition, published in 1958, is an unabridged republication of War Department Technical Manual TM 30-944.

Ed.

Book—5910. Sell, L. L., English-Spanish comprehensive technical dictionary, Section II, New York, McGraw-Hill Book Co., Inc., 1959, iv + 1079 pp. $35.

The compilation of this Section II of English-Spanish Comprehensive Technical Dictionary, originally planned as a Supplement, has now become inescapable as a result of the unusually large number of technical terms which have been developing since the publication of the original volume in 1944. The 1944 parent work and the present Section II combine into a mutually complementary sequence, and offer a good up-to-date picture of the present state of technical, scientific, and commercial progress in these two important languages.

The most modern feature of Section II, however, is the nomenclature seeking to express the newly emerging terminology of space travel with its conceptual instrumentation of spaceships, spacemen, space stations, and all that they imply, for round-trip travels to and from the very edge of the universe itself.

This volume contains 400,000 English and Spanish technical terms and expressions. From author's preface

Elasticity

(See also Revs. 5942, 5964, 5968, 5972, 6027, 6037, 6038, 6064, 6069, 6070, 6082, 6125, 6146, 6401)

Book—5911. Kroner, E., Continuum theory of dislocations and residual stresses [Kontinuumstheorie der Versetzungen und Eigenspannungen], Berlin, Springer-Verlag, 1958, vii + 179 pp. DM 17.10 (paperbound).

In conventional static linear elasticity one seeks to solve for the stresses σ_{ij} and strains ε_{ij} from the equilibrium equations, the compatibility equations, and Hooke's law

$$\text{Div } \sigma + F = 0, \qquad \text{Inc } \varepsilon = 0, \qquad \sigma = C\varepsilon$$

subject to suitable boundary conditions. Here Div $\sigma \equiv \nabla \cdot \sigma$, Inc $\varepsilon \equiv \nabla \times \varepsilon \times \nabla$, and σ, ε, C are tensors. This book treats problems where the central relation is replaced by the more general Curl $\beta = \alpha$; here $\beta = \varepsilon + \omega$ is the "distorsion" tensor, the strain ε and the rotation ω its symmetrical and antisymmetrical components, and both ε and ω have now compatible and incompatible components. α is the "dislocation density tensor"; it generalizes the notion of isolated dislocations. When the rotation is zero then Curl $\beta = \alpha$ may be replaced by Inc $\varepsilon = \alpha$ Curl. The new formulation permits a more lucid treatment of problems concerned with cavities, inclusions, inhomogenities, dislocations (or distributions thereof). Of primary interest is the force acting on any of these, and the associated elastic energy, when these are by themselves, or interact with each other, or interact with an imposed stress field. In solving these problems—all of them three-dimensional—extensive use is made of techniques familiar in electromagnetic theory (ideas of mutual inductance, Biot-Savart law, Lorentz force are used), and, horrible dictu, extensive (and successful) use is made also of the Maxwell-Morera stress functions. Occasionally the assumption of small distorsions (and in one instance that of the symmetry of the stress tensor, for the effect of magnetostriction) is dropped.

Chapter Headings: I Dislocations in the continuum: Geometry. II. Dislocations in the continuum: Statics. III. Dislocations in the crystal. IV. Non-Riemamian geometry of the dislocations. V. Applications.

Bibliography contains 180 items, of which only a handful were written by so-called "Applied Mechanics" elasticians (and even these references pertain mostly to the Italian school at the turn of the century); the balance were written by "Solid-State Physics" elasticians, which includes also the author. The tempo of the book is, correspondingly, fast, the demands on the reader's preparation great. (The going was rough for this reviewer; a better knowledge of differential geometry would have facilitated the task.) But the effort is rewarding; it opens new vistas to the reader. He sees not only a wealth of new results in the (according to many, dying) field of linear static elasticity, solved by new methods, but also a number of new fundamental equations.

G. Horvay, USA

Book—5912. Dinnik, A. N., Selected works, Vol. 2: Applications of Bessel functions to the theory of elasticity [Izbrannye Trudy. Tom 2: Prilozhenie funksii Besselyak zadacham teoerii uprugosti] 2nd ed., Kiev, Izdatel'stvo Akademii Nauk Ukrainskoi SSSR, 1955, 125 pp.

This volume has two parts. The first, *Statics*, was published in 1913 by the Don Polytechnic Institute, where the author held the chair in theoretical mechanics; the second, *Theory of vibrations*, was published in 1915 by the Ekaterinoslav Metallurgical Institute. These two articles treat boundary-value problems which, after separation of variables, lead to solutions in Bessel functions. Emphasis is given to the form of the solutions and their physical meaning. Tables are given to facilitate applications. Citations of the work of then contemporary, non-Russian scientists are continually made. Among the topics treated are a circular plate under a symmetric load, stable compression of a circular plate, longitudinal bending, torsion, a flexible cable under a variable load, theory of a circular membrane, longitudinal and transverse oscillations of a rod, and torsion oscillations of a disk.

N. D. Kazarinoff, USA

5913. Voitsekhovskaia, K. F., Stable equilibrium of bars in the mathematical theory of elasticity, *Soviet Phys.-Doklady* **3,** 2, 442-445, Dec. 1958. (Translation of *Doklady Akad. Nauk SSSR (N. S)* **119,** 5, 903-906, Mar.-Apr. 1958 by Amer. Inst. Phys., Inc., New York, N.Y.)

The rigorous solution for the classical "Euler case" for a round cylindrical bar under axial compression is found by methods of the mathematical theory of elasticity.

Paper treats three-dimensional problem of the cylinder of arbitrary length and radius, compressed by forces uniformly distributed over its end faces. In addition to the initial equilibrium state of the cylinder, author investigates another infinitely close state with deformed noncylindrical lateral surface. Taking into consideration that additional displacements of points of the cylinder and the corresponding stresses must satisfy the equilibrium and boundary conditions, the system of three linear equations is obtained. Nontrivial solution of this system presents the value of the critical compression stress, expressed as a function in powers of a certain patameter t. From the exact solution it follows that for a cylindrical bar with hinged ends, the Euler formula is limiting case when t approaches 0.

A numerical example is analyzed for a steel bar. It is shown that the difference in stresses estimated by the exact and Euler formulas is of the order of a fraction of one per cent, the exact formula giving the higher values. However, a reduction of slenderness ratio resulted in a significant increase of this difference, which could be of importance in practical problems.

M. S. Troitsky, Canada

5914. Chang, C.-C., Fang, B. T., and Ebcioglu, I. K., Elastic theory of a weak-core sandwich panel, initially warped, simply supported, and subjected to combined loadings, Proc. Third U. S. Nat. Congr. Appl. Mech., June 1958; Amer. Soc. Mech. Engrs., 1958, 273-280.

Differential equations for elastic bending and deflection of weak-core sandwich panels are derived for small deflections. Principal assumptions are that forces parallel to the plane of the panel are taken entirely by the facings, the core behaves like a homogeneous elastic continuum undergoing considerable transverse shearing deformation during deflection, and failure does not occur at the bonds. Facings may have different moduli of elasticity and the core is elastically orthotropic. An expression for total potential energy is derived and solved to give the differential equations.

A. G. H. Dietz, USA

5915. Suncheleyev, R. Ya., The equilibrium of an elastic isotropic strip with predetermined displacements at the boundary (in Russian), *Nauchn. Zap. Lvovsk. Politekhn. In-ta* no. 38, 45–52, 1956–1957; *Ref. Zh. Mekh.* no. 2, 1958, Rev. 2067.

Analysis of the elastic equilibrium of an isotropic layer in the presence of given, doubly-differentiated, restricted displacements at its boundaries (edges). The problem is solved by the group method on the assumption that spatial forces are absent. The solution is developed in matrix form, and sought in the form of a Fourier expansion. For the k-th harmonic, the solution is obtained in evident form. For the convergence of the series, the given edge displacements must satisfy additional conditions. It is pointed out that the suggested method can be used for the solution of the case when the stresses on one boundary of the layer are determinate, or when a stress is given on one boundary and a displacement on the other.

I. P. Sheremet'ev

Courtesy Referativnyi Zhurnal, USSR

Translation, courtesy Ministry of Supply, England

5916. Kholmyanskii, M. M., A plane problem for a round sector (in Russian), *Trudi Mosk. In-ta Inzh. Zh.-d. Transp.* no. 92/11, 201–210, 1957; *Ref. Zh. Mekh.* no. 4, 1958, Rev. 4406.

The plane problem is investigated for a round sector with rectilinear sides fastened in such a way that the points of these sides cannot effect normal changes of position, the sector being under the action of a single radial concentrated force, applied at some point in the sector's arc. The solution of this problem merges with the solution of the problem for a round disk of the same radius, as also with the sector with a cyclic system of radial single forces, applied along the disk's contour. The last problem is solved by the Kolosov-Muskhelishvili method. Some special cases are examined dealing with sectors consisting of an infinite semistrip and semiplane, subjected to the action of a concentrated force.

G. N. Savin

Courtesy Referativnyi Zhurnal, USSR

Translation, courtesy Ministry of Supply, England

5917. Adams, E., Two-dimensional stresses in a rotating circular disc with the thickness profile $h(r) = 1/(ar^{2/3} + b)$ which is loaded on the axially symmetrical edge (in German), *Z. Fluguiss.* **6**, 5, 151–153, May 1958.

The two-dimensional analytical method given in author's previous paper [AMR **12** (1959), Rev. 3225] is used to determine the stress distribution in a rotating disk with specified thickness profile.

L.-W. Hu, USA

5918. Kaufman, R. N., Solutions of some boundary-value problems of static theory of elasticity for a layer with a spherical cavity, *Appl. Math. Mech.* (*Prikl. Math. Mekh.*) **22**, 3, 451–465, 1958. (Pergamon Press, 122 E. 55th St., New York 22, N.Y.)

By means of a method used for the solution of the electrostatic problem, author solves some boundary-value problems of the theory of elasticity for regions with parallel sides and containing a spherical cavity. The solution is of the form $u = u_0 + u_1$ where u_0 is the solution for a similar region with the same boundary conditions but without a cavity. The term u_1 is sought in the form of a series of spherical functions relative to the center of the cavity. Formulation and solution of several problems are given.

M. Holt, USA

5919. Volkov, S. D., The scale effect in complex stress conditions (in Russian), *Fiz. Metallov i Metallovedeniye* **2**, 3, 428–440, 1956; *Ref. Zh. Mekh.* no. 2, 1958, Rev. 2177.

Author starts from his previous researches [*Zh. Tekhn. Fiz.* **23**, 11, 2025–2038, 1953] in which a new "uniform statistical theory of strength" was suggested. This last is founded on the formal application of statistical mechanics to a model of a quasi-isotropic, monophase polycrystalline body, on the assumption that the modulus of distribution of the crystallite volumes according to the applied stress is a function of the external load. The breakdown (of brittle substances) is conceived as the result of the action of localized tensile microstresses, on the condition that the microscopic cracks (fissures) combine to form one macroscopic crack. It is then statistically possible to determine the relationship between strength and size of the body. Author applies this theory to the state of complex stress, and finds that the scale effect is related to the particular form of stress condition present. In particular, it has proved that in pure (simple) shear it is greater than in the condition of uniaxial tension, and for uniaxial compression it is greater than for tension. In the abstractor's opinion, the scale effect cannot be considered in its purely statistical aspect without considering the part played by the potential energy of the system. [Cf. E. Shevandi, I. Razo, B. Serpenina, *Dokladi Akad. Nauk SSSR* **113**, 5, p. 1057, 1957.]

N. N. Davidenkov

Courtesy Referativnyi Zhurnal, USSR

Translation, courtesy Ministry of Supply, England

5920. Marcus, H., The concept of virtual stress patterns and its applications to stability problems in continuum mechanics (in English), 9th Congrès Intern. Mécan. Appl., Univ. Bruxelles, 1957; **7**, 21–31.

A shear stress equation is properly selected to satisfy all boundary conditions. This equation together with equilibrium equations gives a particular solution for the two normal stresses and the associated shear stress in a two-dimensional stress problem. Additional requirements, such as minimization of elastic energy, or minimization of the difference between principal stresses, provide complimentary stress terms.

The method is especially helpful in evaluating stresses in large bodies. Author claims that tests indicate his method predicts sliding surfaces in soil mechanics more accurately than conventional theories.

J. D. Marketos, USA

5921. Piechocki, W., The stresses in an infinite wedge due to a heat source (in English), *Arch. Mech. Stos.* **11**, 1, 93–109, 1959.

This valuable paper determines the state of stress provoked in a homogeneous isotropic plate in the form of an infinite wedge by a concentrated heat source of prescribed strength acting at any point of the plate. The results form the most convenient starting point for solving other advanced problems of thermoelasticity, e.g. that of the stress due to a discontinuous temperature field.

In the sense of the excellent work by Melan and Parkus, the author's deductions are based upon the potential of thermoelastic displacement which is found to have the form of infinite series. In special cases of an infinite quadrant and a semi-infinite elastic plate, those series can be summed up and result in known functions.

V. Vodicka, Czechoslovakia

5922. Nowacki, W., Thermal stresses due to the action of heat sources in a viscoelastic space (in English), *Arch. Mech. Stos.* **11**, 1, 111–125, 1959.

Sternberg's correspondence principle enables the author to determine thermal stresses in problems of viscoelastic space by us-

ing the solutions of the analogous problems for a perfectly elastic body.

Author's considerations are concerned with thermal stresses provoked in a viscoelastic space by the action of a concentrated, linear and plane heat source. Special attention is paid to the Kelvin and to the Maxwell model of the viscoelastic space.

Author solves his problems by two different ways: on the one hand by the common method of the potential of thermoelastic displacement; on the other by generalizing to viscoelastic problems the method of V. Z. Mayzel. The results are to be considered as a valuable contribution to advanced thermoelasticity.

V. Vodicka, Czechoslovakia

5923. Nowacki, W., Steady-state thermal stresses in plates (in Polish), *Rozprawy Inż.* **7**, 1, 3–24, 1959.

This paper belongs to the important category of technical literature making practical use of theoretical methods for actually solving advanced problems in engineering. The question is about deflection, bending moments and torques provoked in an elastic plate of moderate thickness by a temperature field linearly varying along the thickness.

The general form of the deflection is obtained with the aid of appropriate Green's functions and can also be expressed in terms of the deflection due to a nucleus of thermoelastic strain acting in any point of the plate. Problem is completely solved both for continuous and discontinuous temperature fields in a number of cases such as that of an infinite plate, infinite and semi-infinite strip, infinite wedge, etc.

Author's deductions conclude with some problems relating to infinite and semi-infinite plates on an elastic foundation. Reviewer gladly recommends this fine and useful piece of work to engineers and physicists. V. Vodicka, Czechoslovakia

5924. Hillier, M. J., Thermal stresses in reactor shells due to γ-irradiation, *J. Nuclear Energy* **8**, 1/3, 33–47, Nov. 1958.

Paper gives formulas for calculating the temperatures and stresses in flat plates (restrained from bending), cylindrical shells (away from ends) due to exponential heat generation arising from gamma heating. It considers (a) surface away from incident gamma ray beam insulated, (b) equal surface temperatures and (c) finite resistances on each face. Cases (a) and (b) are presented for the sphere. Stress distributions are evaluated for the flat plate; peak stresses for the cylinder, and the equations are presented for the sphere. Paper indicates that flat plate approximation is good for most cases in practice. Reactor designers in USA have used results of "Stresses in long thick-walled cylinders caused by pressures and temperatures," by Sonnemann and Davis, ASME Paper 57-A-256. The latter paper disregarded the geometric correction factor for heat generation for the thin-walled cylinder which present paper considers. Present paper is more complete and very clearly presented. R. J. Fritz, USA

5925. Goodier, J. N., Formulas for overall thermoelastic deformation, Proc. Third U. S. Nat. Congr. Appl. Mech., June 1958; Amer. Soc. Mech. Engrs., 1958, 343–345.

Use is made of the known fact that for the calculation of the displacements the temperature field may be replaced by body and surface forces. Subsequently the Betti reciprocal theorem is used. A result of Hieke [AMR **9** (1956), Rev. 2139], which states that there is only an overall change of volume $3\alpha TdV$, is confirmed. Indeed it can be said that overall change of volume is due to thermal expansion only (and not to thermal stresses), though of course the volume strains caused by the thermal expansion only are noncompatible.

Formulas are found for the change of contained volume of thick-walled closed vessels, and for overall extensions, deflections and rotations of flexural and torsional types, in bars of arbitrary section. J. P. Benthem, Holland

5926. Small, N. C., Pressure and thermal stress analysis of plate-type fuel subassemblies, Proc. Third U. S. Nat. Congr. Appl. Mech., June 1958; Amer. Soc. Mech. Engrs., 1958, 451–459.

Construction mentioned in the title consists of a series of long parallel rectangular fuel plates built together by two side plates perpendicular to them. Spacing left between fuel plates forms channel for coolant. Stresses in side plates, due to variation of temperature and fluid pressure, are investigated. Construction is regarded as composed of series of elemental frames, and difference equations are formulated expressing the requirements of continuity.

Numerical results obtained are compared with those of a simplified theory, which considers side plate to be supported on a continuous elastic foundation. Agreement between both theories is quite good for the case of bending moments.

Comparison with photoelastic test shows that, in case of thermal loading, theory overestimates the side plate moments by about 100%. Discrepancy can be attributed to the applied assumptions. Pressure loading case shows a better correlation with experimental data. O. Halasz, Hungary

5927. Sternberg, E., On transient thermal stresses in linear viscoelasticity, Proc. Third U. S. Nat. Congr. Appl. Mech., June 1958; Amer. Soc. Mech. Engrs., 1958, 673–683.

Author formulates a principle of correspondence between quasi-static solutions in linear elasticity and viscoelasticity for problems involving a time-dependent temperature field. With this principle thermal stresses are determined in an infinite viscoelastic medium with a spherical cavity, temperature having a polar symmetry. A solution in integral form is possible, provided mechanical and thermal parameters are temperature-independent. Closed explicit solutions are given in a special case for a Maxwell or a Kelvin solid. A. Isaksson, Sweden

5928. Talypov, G. B., Deformation and stresses at points in a sheet, due to rectification by heat treatment (in Russian), *Uch. Zap. LGU* no. 217, 272–287, 1957; *Ref. Zh. Mekh.* no. 4, 1958, Rev. 4568.

Author solves the problem on central heating of a sheet, evenly distributed according to its thickness, the sheet having no dimensional limits. In so doing he assumes for the sake of simplification that the resistance of the metal to plastic deformation remains unchanged up to a temperature of 600°, but beyond that drops to zero. In this way he finds the value of the plastic deformability of a circle in the sheet with radius a, which evokes stresses and elastic-plastic deformations in remaining portion of the sheet. The problem of distribution of stresses in the sheet outside the circle is solved from the Huber-Mizes conditions of plasticity, and an experimental check is carried out. To conclude his paper, author puts forward some deductions regarding: the formation of residual stresses in sheets when they are centrally heated, because of welding; the influence of some technological parameters on the magnitude of these stresses; the formation of residual stresses due to hot rectification by means of concentrated heat sources; and the local changes in the properties of the metal in the rectifying zone.

G. A. Nikolaev

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5929. Tchilingarishvili, G. I., A graphic-analytical method for solving the two-dimensional axially-symmetrical problem of thermoelastic equilibrium (in Russian), *Izv. Vses. N.-i. In-ta Gidrotekhn.* no. 57, 135–149, 1957; *Ref. Zh. Mekh.* no. 2, 1958, Rev. 2070.

An examination of the two-dimensional, axially-symmetrical problem of the thermoelastic equilibrium of a long, hollow cylinder, in two variants: (1) The resultant of the normal stresses in the cross section is zero; (2) displacements along the axis of the cyl-

inder are zero; there is no load on the lateral surfaces of the cylinder. Equations are presented determining the stress components, deformations, and radial displacements linearly by the temperature in a given point T and the mean temperatures

$$\bar{T}_b = \frac{2}{(b^2 - a^2)} \int_a^b rT\,(r)\,dr, \quad \bar{T}_r = \frac{2}{(r^2 - a^2)} \int_a^r rT\,(r)\,dr$$

respectively, of the hollow cylinder (a and b, internal and external radii) and the part of the cylinder enclosed between cylindrical surfaces with the radii a and r. These expressions enable, with the aid of curves of the quantities T and $\bar{T}_r$, a simple determination of the curves of the normal stresses σ_r, σ_φ, and σ_z. The transition at the limit furnishes a solution of the problem of thermoelastic equilibrium of an infinitely extending body with a cylindrical cavity. A solution is given for the problem of the elastic equilibrium of a hollow cylinder contained in an elastic medium, when the temperature distribution in the walls of the hollow cylinder is axially-symmetrical in one plane and in the elastic medium.

V. K. Prokopov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5930. Eras, G., and Elze, H., Contribution to the calculation of orthotropic plates supported by unidirectional, torsionally stiff hollow ribs (in German), *Stahlbau* **27**, 12, 314–317, Dec. 1958.

Based on the theory of orthotropic elastic plates as developed by W. Cornelius [*Stahlbau*, 1952] and by F. W. Mader [*Stahlbau*, 1957] in which the torsional stiffness is greater than the arithmetic sum of the two bending rigidities, authors' propose exact solutions for rectangular plates in which the longer pair of edges is simply supported while along the shorter pair of the edges arbitrary boundary conditions are prescribed and the plates carry a uniform lateral load acting within a rectangular area. The solutions for a number of special cases under such partially loaded plates are expressed in terms of simple Fourier series. Examples include the infinitely long parallel strip and half-strip.

The Fourier coefficients are explicitly evaluated for the various boundary conditions and types of lateral loads. The aforementioned assumptions cover the practically important cases when the rectangular plates are stiffened by a system of welded-on parallel hollow ribs.

A. L. Nadai, USA

5931. Markovets, M. P., Method for determining the limit of plasticity during torsion (in Russian), *Zavod. Lab.* **23**, 6, 715–720, 1957; *Ref. Zh. Mekh.* no. 5, 1958, Ref. 5787.

A comparison is furnished between the limits of deformation during tension and torsion and the characteristics of transverse constriction. Formulas are derived connecting the magnitude of the transverse constriction of the surface layer during torsion with the magnitude of the angle of shear. It is asserted, on the basis of experiments, that during torsion at the point of disruption localization of the deformation is observed (the angles of shear at the point of disruption are of great significance). Utilizing the proposed formulas, a series of comparisons for various materials is carried out for the limits of deformation during torsion and tension. It is shown that the proposed method gives better convergence than the comparison of deformations during tension and torsion carried out on the basis of contrasting maximum and octahedral shears.

Yu. A. Rakovshchik

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5932. Severn, T. T., Shrink-fit stresses between tubes having a finite interval of contact, *Quart. J. Mech. Appl. Math.* **12**, 1, 82–88, Feb. 1959.

Author proposes relaxation methods to find shrinkage stresses for infinite tubes in finite contact, and finite tubes in finite contact, all under unit radial pressure at contact. Key to method is obtaining radial displacement distribution (for each tube separately) for use in an integral equation to find shrinkage stresses. Numerical examples are cited and compared with the infinite-contact case (Southwell).

Z. W. Dybczak, Canada

5933. Stemberg, E., and Koiter, W. T., The wedge under a concentrated couple: A paradox in the two-dimensional theory of elasticity, *J. Appl. Mech.* **25**, 4, 575–581, Dec. 1958.

The classical plane stress-plane strain solution to the wedge (angle 2α) problem for a concentrated moment Q, applied at the vertex, has a stress function solution

$$\phi = Q(2\theta \cos 2\alpha - \sin 2\theta)/2(\sin 2\alpha - 2\alpha \cos 2\alpha)$$

indicating that the radial and shear stresses become infinite throughout the field for the critical angle $\alpha_* = 0.715\,\pi$.

By considering the concentrated moment as caused by an equivalent *normal antisymmetric* surface loading in the immediate neighborhood of the vertex, in the limit as the length of the surface of loading $\longrightarrow 0$, authors show that the above solution is valid only for the range of values

$$0 < \alpha < \alpha_*$$

In a footnote and a "Note added in proof," authors state that a consideration of possible *symmetric* surface (normal?) loadings indicates that the range of validity of the solution (which must be independent of the type of equivalent loading assumed) is given by

$$0 < \alpha \leq \pi/2$$

and that this governs, rather than the range given above.

Reviewer suggests the inclusion of *symmetric* and *antisymmetric shear* surface forces and *unsymmetric* concentrated surface moments (which are also possible equivalent surface loadings and apparently were not considered by the authors) may further modify the conclusions as to the region of validity of the classical solution.

Authors claim the analysis indicates still another case in which the conventional simplified statement of the Saint-Venant principle is contradicted.

S. F. Borg, USA

Viscoelasticity

(See also Revs. 5922, 5927, 5988, 5990, 6045, 6073, 7079, 6086, 6150)

5934. Blaszkowiak, St., Influence of creep in a composite (steel-concrete) beam (in German), *Bautechnik* **35**, 3, 96–100, Mar. 1958.

Author refers to Swiss specifications for determining the creep effect in composite bridge structures by introducing combined modulus of elasticity of concrete [*Schweiz. Bauztg.* July 28, 1956] and compares the results with those obtained by his method. Author and his students applied both methods on an example of a composite bridge structure calculated in Sattler's book "Theorie der Verbundkonstruktionen" (Theory of composite structures). The results of both methods are tabulated and the conclusion is made that the author's method, based on standard procedure used for such structures without consideration of the creep effect, complies with Swiss regulations. Author's modifications are thoroughly discussed and illustrated, and demonstrate considerable simplification of the analysis.

J. J. Polivka, USA

5935. Lepin, G. F., On the statistical theory of creep and relaxation (in Russian), *Izv. Akad. Nauk SSSR, Otd. Tekh. Nauk* no. 9, 134–136, Sept. 1957.

Replacing the curve of the dislocation distribution against the activation stress by the curve of stress against the instantaneous

[illegible] this latter being experimentally obtained for a class of steels, author assumes that the rate of strain is proportional to the probability of existence in the test piece of the dislocations of minimum activation energy at stress $\left(\beta \frac{d\varepsilon}{dt} = \beta k \varepsilon_s\right)$ and also proportional to the probability of the occurrence in the test piece of the thermal fluctuations ($e^{-\alpha/\sigma^2 s}$) obtained by N. F. Mott, so that $\frac{d\varepsilon_s}{dt} = \alpha k \varepsilon e^{-\alpha/\sigma^2 s}$.

Particularizing the results, author obtains E. N. Andrade's empirical formula in the case of damped creep, and, in the case of relaxation, an equation similar to those obtained by Iu. N. Rabotnov, V. I. Feodos'ev and V. M. Ivanova.

M. M. Mirsu, Rumania

5940. Kloppel, K., and Yamada, M., Yield polyhedron of the rectangular and I-cross section under the action of bending moment, normal force and shearing force (in German), *Stahlbau* **27**, 11, 284–290, Nov. 1958.

Yield polyhedrons in terms of bending moment, normal force and shearing force are constructed for ideally elastic, ideally plastic material with a view of application to the limit analysis of frames. The yield criterion of Mises-Huber-Hencky is used. The shearing stress distribution is curvilinear. In the case of I-cross section it is assumed that the shearing force is taken up by the web only.

The physical characteristics of the yield polyhedron are also discussed.

R. Schmidt, USA

5941. Ho, L. W., Determination of the plastic stress-strain relations in tension of Nitinay No. 2 brass under hydrostatic pressure, Proc. Third U. S. Nat. Congr. Appl. Mech., June 1958; Amer. Soc. Mech. Engrs., 1958, 557–562.

This paper describes a new triaxial stress testing method for studying the plastic behavior of metals. Tension tests were conducted on a Nitinay No. 2 free-machining brass under hydrostatic pressures up to 83,200 psi. Effects of hydrostatic compression on work-hardening coefficient, strength coefficient, average true stress at rupture and reduction in cross-sectional area at rupture are reported.

From author's summary

5942. Lin, T. H., On stress-strain relations based on slips, Proc. Third U. S. Nat. Congr. Appl. Mech., June 1958; Amer. Soc. Mech. Engrs., 1958, 585–587.

Basic assumptions used in the slip polycrystal stress-strain relations of Taylor and Bailhache are compared to those assumptions in the slip stress-strain relations proposed by the writer. The latter slip theory is modified to include the effect of latent hardenings. A number of inelastic loadings have been calculated. On the whole calculations, the present theory gives better agreement than the previous theories.

From author's summary

5943. Nyman, L., Drawing die—sensitivity at design, Proc. Third U. S. Nat. Congr. Appl. Mech., June 1958; Amer. Soc. Mech. Engrs., 1958, 551–556.

The object method is design a drawing die that is profiled easy which is done entirely by conventional plastic methods. The minimum weight die is investigated, and it is shown that a practical die approximates very closely to its ending dimensions of the minimum weight die. A rationale, on axial length of a die, is given as an alternative to the precise form of profile, which makes it almost true all over metal workpiece. This investigation is carried by using plastic analysis.

From author's summary

5944. Parsons, K., and Hodge, P. G., Jr., Strain-hardening circular cylinders with symmetrical kinematic models, Proc. Third U. S. Nat. Congr. Appl. Mech., June 1958; Amer. Soc. Mech. Engrs., 1958, 417–423.

[illegible]

From author's summary

5945. Vinogradov, I. N., and Yaghn, Yu. I., The laws of plasticity (in Russian), *Fiz. Metallov i Metallovedeniye* **3**, 1, 127–134, 1956; *Ref. Zh. Mekh.* no. 2, 1958, Rev. 2130.

A presentation of the results of experimental investigation of the plastic deformation of metals at values of the parameter

$$\mu = \frac{2\bar{\sigma}_2 - \bar{\sigma}_1 - \bar{\sigma}_3}{\bar{\sigma}_1 - \bar{\sigma}_3}$$

between 0 and −1 for $\mu = +1$. All experiments were conducted in conditions of simple loading. The tests were made with samples of beryllium bronze, technically-pure iron, and aluminum bronze. To eliminate the anisotropy of the samples, they were annealed and tempered. Authors attempt to establish a relationship between the stress and deformation intensities, and between the kinds of stress and deformation deviators. It is found that the divergence of the curves plotted in $\sigma_i - e_i$ coordinates for a particular value of μ is determined by the value of the mean normal stress. For varying values of μ, the influence of the stress deviator becomes determinant. For $\mu = +1$, and 0, confirmation is obtained of the similarity between the stress and deformation deviators. For the case of aluminum bronze, the similarity between the stress and deformation deviators is maintained also at other value of μ. The results of these experiments enable approximate relationships to be established so that deformations for any given stress condition can be calculated. T. V. Sokolova

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5946. Mezhlumyan, R. A., Three-dimensional stability of structures in the presence of elastic-plastic distortions (in Russian), *Inzhener. Sbornik* **14**, 31–72, 1953; *Ref. Zh. Mekh.* no. 2, 1958, Rev. 2137.

The results obtained by the author on the theory of thin-walled columns and cylindrical shells distorted beyond the elastic limit are presented. The case is examined in which the load is both applied and removed. The work is based on V. Z. Vlasov's theory of thin-walled columns and the theory of the stability of plates and shells beyond the elastic limit developed by A. A. Ilyushin. A numerical example is given.

Yu. N. Pabotnov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5947. Donetz, A. T., The phenomenon of recovery during plastic torsion of aluminum (in Russian), *Trudl Sib. Fiz.-Tekhn. In-ta* **34**, 275–282, 1955; *Ref. Zh. Mekh.* no. 2, 1958, Rev. 2382.

Plastic deformation is accompanied by two phenomena: strain hardening and recovery. The recovery characteristic, the so-called coefficient of recovery

$$a = \frac{\Delta\sigma}{\sigma_0 \Delta_t}$$

is determined from the relaxation curves. In the above, $\Delta\sigma$ is the stress reduction during the time Δt from the initial stress σ_0. The relationship between the recovery coefficient and the deformation and stress intensities is investigated on test results in torsion of thin-walled aluminum tube samples, of Grade A1-2, at 17, 100, 200, 300 and 400°. The sample was twisted at either 0.025 or 0.675 rpm rate of deformation through one of the five angles 30, 100, 160, 290 and 420°, after which it was relaxed. The recovery coefficient was found to be independent of the degree of deformation and stress level. V. S. Namestnikov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5948. Agranat, N. N., and Shirokov, M. F., The theory of the method of determining the limiting shear stress in disperse systems by the penetration of a cone (in Russian), *Kolloidn. Zh.* **19**, 1, 9–13, 1957; *Ref. Zh. Mekh.* no. 2, 1958, Rev. 2136.

The problem is examined of the limiting equilibrium of a cone penetrating into a plastic medium. The solution, which is obtained in closed form, confirms the correctness of the Rehbinder equation for a conical plasticity meter [cf. P. A. Rehbinder, B. Ya. Yampolsky, *Kolloidn. Zh.* **10**, 6, p. 466, 1948], but the formula for calculating the cone constant K appears in a different form. The numerical values of the constant K are found to be close to those found by a graphical method in the paper by N. N. Agranat and M. P. Volarovich [*Kolloidn. Zh.* **19**, 1, 3–8, 1957]. The values of the constant K have been calculated for different opening angles of the cone; the results obtained are illustrated by charts.

N. I. Malinin

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

Rods, Beams and Strings

(See also Revs. 5869, 5913, 5936, 5937, 5939, 5984, 5986, 5999, 6033, 6060, 6099)

5949. Massányi, K., Displacement and working forces at guyed structures with regard both to tension and slack of cables (in Hungarian), *Mélyépitéstudományi Szemle* **8**, 12, 513–521, Dec. 1958.

This paper establishes practical formulas which express the relations between rope force and tower deflection, when (as it really occurs) the windward and leeside ropes are working simultaneously. Diagrams and numerical tables facilitate the computation. The author demonstrates that in cases of anchorages in 3, 4 or 6 directions the rope forces computed in this way give decrements of 10–25% against the rope forces computed in usual approximate way. Hence the proposed method leads to more economic structures. The proposed method is suitable and useful also for computing the cases of nonsymmetrical guy directions and unequal rope lengths. The whole theory is based on the assumptions that the shape of rope can be characterized by a parabola of second degree and the length of rope can be calculated by means of a formula of second degree. These assumptions are acceptable for practical purposes. A treatment of the theory, without these assumptions, was presented by the reviewer [*Bauingenieur* **14**, no. 33/34, 1933]. J. Barta, Hungary

5950. Mitchell, T. P., The nonlinear bending of thin rods, *J. Appl. Mech. (Trans. ASME*, Series E) **26**, 1, 40–43, Mar. 1959.

Author obtains closed form solutions of the deflected positions for the Bernoulli-Euler beam problem in which the exact expression is used for the curvature (hence resulting in a nonlinear differential equation) for the following constant-section rectilinear or circular-shaped cantilever beams: (1) with point loadings; (2) with a particular uniformly distributed vertical load and a particular concentrated load acting horizontally at the free end; and (3) with a uniform load normal to the cantilever.

S. F. Borg, USA

5951. Pfefferkorn, W., Contribution to the analysis of beams with sharp circular curvature (in German), *Maschinenbautechnik* **8**, 1, 40–45, Jan. 1959.

In sharply curved beams with thin webs, radial and shearing stresses are not negligible as in beams with compact cross sections. Author derives, according to elementary principles, expressions for these as well as the tangential stresses. Shear, bending, and normal forces on a cross section are considered. An example with an I-section is worked out, and a comparison with an exact solution according to elasticity theory is made for a rectangular cross section. The error in tangential stress increases with the ratio of outer and inner radii, b/a, but the shearing stress is cor-

strain ($\varepsilon = e^{-b(c-\sigma)}$), the latter being experimentally obtained for a class of steels, author assumes that the rate of strain is proportional to the probability of existence in the test piece of the dislocations of minimum activation energy or stress $\left(\beta \frac{d\varepsilon}{d\sigma} = \beta b \varepsilon_x\right)$ and also proportional to the probability of the occurrence in the test piece of the thermal fluctuations ($e^{-\alpha \Delta \sigma_x}$) obtained by N. F. Mott, so that $\frac{d\varepsilon_x}{dt} = m b e^{-\alpha \Delta \sigma_x}$.

Particularizing the results, author obtains E. N. Andrade's empiric formula in the case of damped creep, and, in the case of relaxation, an equation similar to those obtained by Ju. N. Rabotnov, V. I. Danilovskaia and C. M. Ivanova.

M. M. Misicu, Rumania

5936. Patel, S. A., and Pandalai, K. A. V., Stress distribution in beams of thin-walled sections in the presence of creep, AFOSR TN 59-174 (Polyt. Inst. Brooklyn, Dept. Aero. Engng. Appl. Mech. Rep. 486; ASTIA AD 211 314), 36 pp., Feb. 1959.

This paper is concerned with the problem of stress distribution in beams of thin-walled sections in the presence of primary as well as secondary creep. The cross sections considered are open sections with an axis of symmetry and circular sections with and without stringer reinforcements. In all these cases, the elastic analog is used to reduce the creep problem to one of nonlinear elasticity. Shear centers of open sections considered are also determined. From authors' summary

5937. Pandalai, K. A. V., and Patel, S. A., A note on shear centers of thin-walled closed sections in the presence of creep, AFOSR TN 59-190 (Polyt. Inst. Brooklyn, Dept. Aero. Engng. Appl. Mech. Rep. 487; ASTIA AD 211 311), 22 pp., Feb. 1959.

This note is concerned with the shift of shear centers of beams of thin-walled closed sections subjected to creep. The elastic analog helps reduce the creep problem to one of nonlinear elasticity. The examples considered are D-section, triangular section and an idealized airfoil section. All the cross sections considered are assumed to have one axis of symmetry.

The results indicate that in the presence of creep the shear center can shift significantly from its position corresponding to the linear, elastic theory. From authors' summary

5938. Namestnikov, V. S., Some questions regarding irregular creep in conditions of a complex stressed condition (in Russian), Avtorefer. Diss. Kand. Fiz.-Matem. Nauk, MGU, Moscow, 1957; *Ref. Zh. Mekh.* no. 5, 1958, Rev. 5834.

Plasticity

(See also Revs. 5911, 5931, 6034, 6047, 6049, 6074, 6078, 6082, 6146, 6151)

5939. Davis, E. A., and Connelly, F. M., Stress distribution and plastic deformation of strain hardening material, *J. Appl. Mech. (Trans. ASME,* Series E) **26,** 1, 25-30, Mar. 1959.

Paper extends Nadai's solution for non-strain-hardening material to cases where there exists a linear relation (a) between octahedral shear stress and octahedral shear strain and (b) between maximum shear stress and maximum shear strain. Stress distributions are presented in each instance for both solid and hollow cylinders.

Authors introduce as a triaxiality factor the ratio 2(hydrostatic tension)/octahedral shear stress, and give one experimental example to indicate that this may show the position of maximum loss of ductility under conditions of combined stress.

K. H. Griffin, England

5940. Kloppel, K., and Yamada, M., Yield polyhedron of the rectangular and I-cross section under the action of bending moment, normal force and shearing force (in German), *Stahlbau* **27,** 11, 284-290, Nov. 1958.

Yield polyhedrons in terms of bending moment, normal force and shearing force are constructed for ideally elastic, ideally plastic material with a view of application to the limit analysis of frames. The yield criterion of Mises-Huber-Hencky is used. The shearing stress distribution is curvilinear. In the case of I-cross section it is assumed that the shearing force is taken up by the web only.

The physical characteristics of the yield polyhedron are also discussed. R. Schmidt, USA

5941. Hu, L. W., Determination of the plastic stress-strain relations in tension of Nittany No. 2 brass under hydrostatic pressure, Proc. Third U. S. Nat. Congr. Appl. Mech., June 1958; Amer. Soc. Mech. Engrs., 1958, 557-562.

This paper describes a new triaxial stress testing method for studying the plastic behavior of metals. Tension tests were conducted on a Nittany No. 2 free-machining brass under hydrostatic pressures up to 53,200 psi. Effects of hydrostatic compression on strain-hardening coefficient, strength coefficient, average true stress at rupture and reduction in cross-sectional area at rupture are reported. From author's summary

5942. Lin, T. H., On stress-strain relations based on slips, Proc. Third U. S. Nat. Congr. Appl. Mech., June 1958; Amer. Soc. Mech. Engrs., 1958, 581-587.

Basic assumptions used in the slip polyaxial stress-strain relations of Batdorf and Budiansky are compared to those assumptions in the slip stress-strain relations proposed by the writer. The latter slip theory is modified to include the effect of latent hardening. A number of inelastic loadings have been calculated. For the cases calculated, the present theory gives better agreement than the previous theories.

From author's summary

5943. Heyman, J., Rotating disks—insensitivity of design, Proc. Third U. S. Nat. Congr. Appl. Mech., June 1958; Amer. Soc. Mech. Engrs., 1958, 551-556.

The plastic method of design of rotating disks leads to profiles very similar to those generated by conventional elastic methods. The minimum weight disk is investigated, and it is shown that a practical disk approximates very closely in its leading dimensions to the minimum weight disk. In particular, the axial length of a disk at its bore is insensitive to the precise form of profile, which makes an elastic trial and error method workable. This insensitivity is examined by using a plastic analysis.

From author's summary

5944. Perrone, N., and Hodge, P. G., Jr., Strain-hardening solutions with generalized kinematic models, Proc. Third U. S. Nat. Congr. Appl. Mech., June 1958; Amer. Soc. Mech. Engrs., 1958, 641-648.

Some general considerations for a theory of plastic strain hardening under biaxial stresses are discussed. It is shown that stresses which are forced to remain zero may still have an influence on the behavior of the material, but that zero strains may be eliminated. Further, it is shown that a suitable change in variable can always be made to give a simple relation between stress and strain in any direction. The results are illustrated in the solution of the bending of an I-beam with unequal flanges. The problem is treated first as a one-dimensional one in terms of the actual stresses, and then as a biaxial one in terms of the resultant moment and axial force. A comparison between the two treatments provides some suggestions for a general theory of biaxial hardening. From authors' summary

5945. Vinogradov, I. N., and Yaghn, Yu. I., The laws of plasticity (in Russian), *Fiz. Metallov i Metallovedeniye* **3**, 1, 127–134, 1956; *Ref. Zh. Mekh.* no. 2, 1958, Rev. 2130.

A presentation of the results of experimental investigation of the plastic deformation of metals at values of the parameter

$$\mu = \frac{2\bar{\sigma}_2 - \bar{\sigma}_1 - \bar{\sigma}_3}{\bar{\sigma}_1 - \bar{\sigma}_3}$$

between 0 and −1 for $\mu = +1$. All experiments were conducted in conditions of simple loading. The tests were made with samples of beryllium bronze, technically-pure iron, and aluminum bronze. To eliminate the anisotropy of the samples, they were annealed and tempered. Authors attempt to establish a relationship between the stress and deformation intensities, and between the kinds of stress and deformation deviators. It is found that the divergence of the curves plotted in $\sigma_i - e_i$ coordinates for a particular value of μ is determined by the value of the mean normal stress. For varying values of μ, the influence of the stress deviator becomes determinant. For $\mu = +1$, and 0, confirmation is obtained of the similarity between the stress and deformation deviators. For the case of aluminum bronze, the similarity between the stress and deformation deviators is maintained also at other value of μ. The results of these experiments enable approximate relationships to be established so that deformations for any given stress condition can be calculated. T. V. Sokolova

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5946. Mezhlumyan, R. A., Three-dimensional stability of structures in the presence of elastic-plastic distortions (in Russian), *Inzhener. Sbornik* **14**, 31–72, 1953; *Ref. Zh. Mekh.* no. 2, 1958, Rev. 2137.

The results obtained by the author on the theory of thin-walled columns and cylindrical shells distorted beyond the elastic limit are presented. The case is examined in which the load is both applied and removed. The work is based on V. Z. Vlasov's theory of thin-walled columns and the theory of the stability of plates and shells beyond the elastic limit developed by A. A. Ilyushin. A numerical example is given.

Yu. N. Pabotnov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5947. Donetz, A. T., The phenomenon of recovery during plastic torsion of aluminum (in Russian), *Trudl Sib. Fiz.-Tekhn. In-ta* **34**, 275–282, 1955; *Ref. Zh. Mekh.* no. 2, 1958, Rev. 2382.

Plastic deformation is accompanied by two phenomena: strain hardening and recovery. The recovery characteristic, the so-called coefficient of recovery

$$a = \frac{\Delta\sigma}{\sigma_0 \Lambda_t}$$

is determined from the relaxation curves. In the above, $\Delta\sigma$ is the stress reduction during the time Δt from the initial stress σ_0. The relationship between the recovery coefficient and the deformation and stress intensities is investigated on test results in torsion of thin-walled aluminum tube samples, of Grade A1-2, at 17, 100, 200, 300 and 400°. The sample was twisted at either 0.025 or 0.675 rpm rate of deformation through one of the five angles 30, 100, 160, 290 and 420°, after which it was relaxed. The recovery coefficient was found to be independent of the degree of deformation and stress level. V. S. Namestnikov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5948. Agranat, N. N., and Shirokov, M. F., The theory of the method of determining the limiting shear stress in disperse systems by the penetration of a cone (in Russian), *Kolloidn. Zh.* **19**, 1, 9–13, 1957; *Ref. Zh. Mekh.* no. 2, 1958, Rev. 2136.

The problem is examined of the limiting equilibrium of a cone penetrating into a plastic medium. The solution, which is obtained in closed form, confirms the correctness of the Rehbinder equation for a conical plasticity meter [cf. P. A. Rehbinder, B. Ya. Yampolsky, *Kolloidn. Zh.* **10**, 6, p. 466, 1948], but the formula for calculating the cone constant K appears in a different form. The numerical values of the constant K are found to be close to those found by a graphical method in the paper by N. N. Agranat and M. P. Volarovich [*Kolloidn. Zh.* **19**, 1, 3–8, 1957]. The values of the constant K have been calculated for different opening angles of the cone; the results obtained are illustrated by charts.

N. I. Malinin

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

Rods, Beams and Strings

(See also Revs. 5869, 5913, 5936, 5937, 5939, 5984, 5986, 5999, 6033, 6060, 6099)

5949. Massányi, K., Displacement and working forces at guyed structures with regard both to tension and slack of cables (in Hungarian), *Mélyépitéstudományi Szemle* **8**, 12, 513–521, Dec. 1958.

This paper establishes practical formulas which express the relations between rope force and tower deflection, when (as it really occurs) the windward and leeside ropes are working simultaneously. Diagrams and numerical tables facilitate the computation. The author demonstrates that in cases of anchorages in 3, 4 or 6 directions the rope forces computed in this way give decrements of 10–25% against the rope forces computed in usual approximate way. Hence the proposed method leads to more economic structures. The proposed method is suitable and useful also for computing the cases of nonsymmetrical guy directions and unequal rope lengths. The whole theory is based on the assumptions that the shape of rope can be characterized by a parabola of second degree and the length of rope can be calculated by means of a formula of second degree. These assumptions are acceptable for practical purposes. A treatment of the theory, without these assumptions, was presented by the reviewer [*Bauingenieur* **14**, no. 33/34, 1933]. J. Barta, Hungary

5950. Mitchell, T. P., The nonlinear bending of thin rods, *J. Appl. Mech.* (*Trans. ASME*, Series E) **26**, 1, 40–43, Mar. 1959.

Author obtains closed form solutions of the deflected positions for the Bernoulli-Euler beam problem in which the exact expression is used for the curvature (hence resulting in a nonlinear differential equation) for the following constant-section rectilinear or circular-shaped cantilever beams: (1) with point loadings; (2) with a particular uniformly distributed vertical load and a particular concentrated load acting horizontally at the free end; and (3) with a uniform load normal to the cantilever.

S. F. Borg, USA

5951. Pfefferkorn, W., Contribution to the analysis of beams with sharp circular curvature (in German), *Maschinenbautechnik* **8**, 1, 40–45, Jan. 1959.

In sharply curved beams with thin webs, radial and shearing stresses are not negligible as in beams with compact cross sections. Author derives, according to elementary principles, expressions for these as well as the tangential stresses. Shear, bending, and normal forces on a cross section are considered. An example with an I-section is worked out, and a comparison with an exact solution according to elasticity theory is made for a rectangular cross section. The error in tangential stress increases with the ratio of outer and inner radii, b/a, but the shearing stress is cor-

rect to about 1% at $b/a = 4$, the error being less for other values of b/a.

The latter value can be compared with a similar solution obtained by Yu [AMR **4** (1951), Rev. 2854]. The largest b/a considered by Yu was 3, for which he found an error of about 0.9%.

A. D. Topping, USA

5952. Rensaa, E. M., Shear, diagonal tension, and anchorage in beams, *J. Amer. Concr. Inst.* **30,** 6, 695–715, Dec. 1958.

5953. Seika, M., The stresses in a thick cylinder having a square hole under concentrated loading, *J. Appl. Mech.* **25,** 4, 571–574, Dec. 1958.

The solution for two diametral loads acting along the diagonal of the square hole or at 45° with the diagonal is approximated by a perturbation method using one perturbation parameter. The success of the method depends upon fitting one curve to both the fillet at the corner and to the side of a given square hole. Reviewer believes this to be impossible with one parameter. However, the numerical example chosen does appear to show good agreement between the approximating curve and the square hole with its fillet. Reviewer believes a photoelastic solution would be more valuable.

N. C. Costakos, USA

5954. Alexiu, I., On the computation of wooden doweled beams (in Roumanian), *Rev. Transporturilor* **5,** 10, 467–477, Oct. 1958.

5955. Cakiroglu, A., The reinforced ceiling supported on torsionally stiff boundary beams (in German), *Bauingenieur* **33,** 8, 294–299, Aug. 1958.

5956. Amenzade, Iu. A., Local torsional stresses in a prismatic circular beam with an eccentric elliptical hole, *Soviet Phys.-Doklady* **3,** 2, 446–450, Dec. 1958. (Translation of *Doklady Akad. Nauk SSSR (N. S.)* **119,** 6, 1118–1121, Mar.–Apr. 1958 by Amer. Inst. Phys., Inc., New York, N. Y.)

Paper shows modification of normal torsional stresses in prismatic circular beam due to eccentric elliptical hole. Pure torsion is considered and stress distribution is such that solution strictly applies only some distance from end of beam. Problem, therefore, is not a common one.

Author uses stress functions satisfying boundary conditions at free surface of beam and round elliptical hole. Numerical solution is by successive approximations and four approximations are generally sufficient for precise solution. Solution requires values of principal axes, a and b, and focal length $4A$ of the elliptical hole and its eccentricity e from the beam axis in terms of the beam radius R.

Example is given for $a/b = 5$; $e/R = 0.375$ and $A/e = 4/25.\sqrt{6}$, and author shows that, at vertices of ellipse, torsional stresses are 5.04 and 17.6 times greater than in normal beam. The larger value refers to vertex nearer to beam axis.

In reviewer's opinion these stresses are result of purely elastic analysis and shape of stress concentration diagram hints at elastoplastic behavior in practice with consequent reduction in concentration.

Author handles difficult problem concisely and expertly.

G. Little, England

5957. Sato, K., Large deflection of thin circular cantilever beams, *J. Appl. Mech.* **25,** 2, 294–295 (Brief Notes), June 1958.

5958. Nudel'mann, Ya. L., and Ovchinnikov, P. F., The bending of bars of variable cross section in the presence of shear displacements (in Russian), *Prikl. Mekhanika* **2,** 1, 40–50, 1956; *Ref. Zh. Mekh.* no. 2, 1958, Rev. 2226.

The energy method is used to derive a system of differential equations for the bending of a straight bar of variable cross section in the presence of shearing displacements. It is demonstrated that in some cases the introduction of shear is capable of giving a far more correct value of the bending deflection, compared with the value obtained by any hitherto used method.

G. S. Pisarenko
Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5959. Mileykovsky, I. E., Determination of the referred rigidity of an orthotropic beam weakened by cross cuts by the method of reducing the spatial elastic problem to a unidimensional form (in Russian), Investigations on problems of structural mechanics and the theory of plasticity, Moscow, 1956, 146–168; *Ref. Zh. Mekh.* no. 2, 1958, Rev. 2073.

The case is examined of an orthotropic beam of rectangular cross section weakened by a great number of cross cuts extending over the total height and occupying half the width of the beam. The cross cuts are made at equal spacings to the right and left, in staggered formation. Author envisages a beam glued from short-length, wooden boards, and sets the problem of finding its referred rigidity. The problem of the beam in pure bending is investigated. Considering that only the integral characteristic must be determined, author states the law of distribution of the stresses and displacements in z (over the height of the beam) and eliminates z, replacing the differential equations of equilibrium of the general theory of elasticity by variational equations. The resulting two-dimensional problem is reduced to the integration of a fourth-order differential equation, which can easily be performed by trigonometric series. Examples are discussed in which the calculations are conducted as far as the determination of β, the coefficient of loss of rigidity of a glued beam compared with a solid beam.

A. L. Gol'denveizer
Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5960. Craemer, H., Improved iteration procedure for continuous beams (in German), *Bauingenieur* **33,** 9, 336–338, Sept. 1958.

The intermediate unknown (moment) of the three-moment equation is expressed as a function of the load and of the two other unknowns and is determined by an iteration process that converges well.

From author's summary by W. R. Osgood, USA

5961. Wöller, G., Computation of continuous beams with constant moment of inertia in each span with the help of Anger's tables (in German), *Bautechnik* **35,** 5, 182–186, May 1958.

Anger's tables in vol. 3 of his book "Zehnteilige Einflusslinien" are calculated for various ratios of moments of inertia $i = \frac{I_c}{I_n}$ and of spans $m = \frac{L_n}{L_c}$, in which ratios n refers to individual spans and c to one characteristic span (either to equal end spans or to any span of the continuous beam to be assumed as constant). The product of these coefficients is designated $k = m.i$. Tables are calculated for so-called "elastic spans" $L'_n = k.\ L'_c$, assuming $L'_c = L_c$ (actual span). Author discusses these relations and proves that Anger's tables are correct for approximately equal coefficients k of all spans and for concentrated loads. Resulting moments at the supports are to be multiplied by I_n/I_c. Main object of the author's article is to introduce a method of how to use Anger's tables with sufficient accuracy for any type of loading and also for influence lines.

J. J. Polivka, USA

5962. Majovsky, T., Analysis of continuous beams with polygonal centerline in plan (in Czechoslovakian), *Stavebnicky Casopis* **5,** 4, 253–268, 1957.

5963. Ray, K. C., Influence lines for pressure distribution under a finite beam on elastic foundation, *J. Amer. Concr. Inst.* **30,** 6, 729–740, Dec. 1958.

With beam divided into 20 equal sections, point load equated to load uniformly distributed over one section, end conditions $M = 0$,

$S = 0$, the finite difference equations for deflections of whole beam are evaluated for unit load at any one section from end to center. 11 tables give results, in part merely interpolated, for parameters $m = (L/20)^4\, Kb/EI$ from 0.0001 to 0.50 (Kb = reaction intensity per unit deflection over beam width b) for convenience of designers. Author states that $m = 0.0001$ can be used for infinitely stiff footings. M. L. Meyer, England

5964. Leonov, M. Ya., and Panassyuk, V. V., The approximate determination of torsional rigidity (in Russian), *Nauchn. Zap. In-ta Mashinoved. i Avtomatiki, Akad. Nauk USSR* **5**, 46–50, 1956; *Ref. Zh. Mekh.* no. 2, 1958, Rev. 2077.

For the determination of the torsional rigidity of a thin-walled beam, the following approximate formula is suggested:

$$C = \frac{4}{3} G \oint b^3(s)\, ds \qquad [*]$$

where $b(s)$ is the distance from a given point on the contour to the centerline [M. Ya. Leonov, *Nauchn. Zap. In-ta Mashinoved. i Avtomatiki, Akad. Nauk USSR* **5**, 41–45, 1956], and integration is performed over the whole contour. Eq. [*] is used to calculate the rigidities when the cross section is a circular sector and a rectangle. The approximate results obtained are correlated with the accurate results. Rigorous evaluations of the limits of applicability of formula [*] are lacking. B. L. Abramyan

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

Plates, Shells and Membranes

(See also Revs. 5868, 5914, 5924, 5930, 5956, 5986, 5991, 5992, 5993, 5994, 6002, 6003, 6128, 6138, 6240, 6343)

Book—5965. Lheureux, P., Calculation of stresses in thin rectangular plates [Calcul des Plaques Rectangulaires Minces], 2nd ed., Paris, Gauthier-Villars, 1957, 36 pp. 500 fr.

An earlier publication dealing with application of Pigeaud method for finding stresses in rectangular plates has been revised and extended to the case of twisting moment and with holes. Useful charts and graphs have been provided.

S. C. Das, India

5966. Uzdalev, A. I., Problem on the nonlinear deflection of a rectangular strip (in Russian), *Sb. Nauchn.-Soobshch. Saratovsk. Avtomob.-dor. In-ta* no. 7, 22–31, 1957; *Ref. Zh. Mekh.* no. 5, 1958, Rev. 5723.

The deflection is examined of a cantilever supported rectangular strip, produced by an evenly distributed load. Differing from the classical presentation of the problem the principle of change of form is taken not as linear but as showing no great change from the linear. By doing this the problem merges with the nonlinear equation. However, the method of the small parameter leads the problem to a successive integration of a biharmonic equation with different boundary conditions. The classical solution of the problem of the deflection of a cantilever with an evenly distributed load is obtained in polynomes, and consequently it is found possible to express the succeeding approximation in polynomes. The numerical calculations given in the paper show very poor convergence of the successive approximations. L. A. Tolokonnikov

Courtesy Referativnyi Zhurnal, USSR
Translation, couresty Ministry of Supply, England

5967. Yakovlev, Yu. V., An investigation of the rigidity of closely perforated slabs (in Russian), *Trudi Kharkovsk. Aviats. In-ta* no. 15, 149–152, 1954; *Ref. Zh. Mekh.* no. 2, 1958, Rev. 2086.

The rigidity of perforated plates with a triangular arrangement of the perforations is investigated. The coefficient of rigidity ψ, representing the ratio of the rigidity of the perforated plate to the rigidity of a continuous plate, is expressed by the empirical formula

$$\psi = 1.18[1 - (d/t)]$$

where d is diameter of a perforation, t pitch of the perforations. This formula is applicable to values of d/t from 0.3 upward.

Yu. N. Rabotnov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5968. Lee, C. W., and Donnell, L. H., A study of thick plates under tangential loads applied on the faces, Proc. Third U. S. Nat. Congr. Appl. Mech., June 1958; Amer. Soc. Mech. Engrs., 1958, 401–409.

Stresses and displacements in a thick plate under tangential loads applied on both faces are obtained by the infinite series method first suggested by Donnell [AMR **8** (1955), Rev. 3692]. The first terms of the series solutions for the various cases investigated represent the classical theory, and the subsequent terms represent the corrections. Authors state that, by the process developed in their paper, the series expressions converge to exact solutions of the elasticity and boundary conditions.

L.-W. Hu, USA

Book—5969. Darevski, V. M., Strength of cylindrical shells [Prochost' tslindricheskikh obolochek], Moscow, State Publishing House of the Defense Industry, 1959, 158 pp. 7.50 rubles.

This volume contains nine rather long papers, each dealing with some aspect of the statics or dynamics of thin elastic cylindrical shells. The first paper, "Calculation of cantilever circular cylindrical shells, loaded on the free edge by uniformly distributed transverse forces," by A. P. Zakharova, employs equations of accuracy comparable to Donnell's small-deflection equations to solve the title problem. Comparisons are made with approximate solutions obtained by beam theory and also membrane shell theory. Charts are presented to illustrate various stress and deflection parameters in the shell. The second paper, "Bending of a cantilever cylindrical shell, reinforced by a rigid ring and loaded by a radial force," by the same author, treats by linear small-deflection theory the problem of the shell stiffened by a rigid ring at the free end and loaded by a transverse radial force at that end. The third paper, "Influence of axial tensile forces on the stability of cylindrical shells subject to torsion and subject to external normal pressure," by R. I. Kshniakin, treats the title problem by use of Donnell's linear small-deflection equations. The stiffening effect of such initial stresses is determined for each type of loading.

The fourth paper, "Stability of cantilever cylindrical shells subject to transverse bending forces and torsion or internal pressure," by V. M. Darevski, treats the instability of such shells loaded by transverse bending forces accompanied by either torsion or internal pressure. Tests of 33 duraluminum shells are reported and test results correlated with linear theory. The fifth paper, "Stability of orthotropic cylindrical shells subject to torsion and normal pressure," by V. M. Darevski and S. N. Kukudzhanov, treats the stability problem by simplified linear theory. This is an extension of an earlier treatment by the first author pertaining solely to isotropic shells. The sixth paper, by S. N. Kukudzhanov, "Stability of orthotropic cylindrical shells subject to external transverse loads with axial tension and subject to torsion with axial tension," treats each of these combined loadings by linear theory.

The seventh paper, by V. V. Serdiukov, "Stability of anisotropic cylindrical shells subject to certain loadings," considers the cases of (a) uniform external pressure, (b) torsion, and (c) combined torsion and uniform external pressure. Simplified linear theory is employed. The eighth paper, "The influence of axial stiffeners on the natural frequencies of vibration of cylindrical shells," by M. V. Nikulin, employs linear shallow shell theory to investigate the effect of stringers on frequencies. The last paper,

by the same author, "Free vibrations of cylindrical shells, preloaded by twisting moments." employs linear theory to investigate the effect of pre-loading a shell with a torsional moment of magnitude close to that necessary to cause torsional buckling.

The entire book is well referenced.

W. A. Nash, USA

5970. Pshenichnov, G. I., Calculations for round net-work systems (in Russian), *Soobshch. Akad. Nauk GruzSSR* **18,** 4, 441–448, 1957; *Ref. Zh. Mekh.* no. 5, 1958, Rev. 5719.

A method for calculating network cylindrical shells of round outline is put forward, based on the technical theory of shells. Formulas are given for the determination of transpositions, forces and moments to meet the case of a shell freely supported along its curved edges on rigid (in its own plane), and flexible (out of its own plane), diaphragms.

A. K. Mroshchinskii

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5971. Ke-Chzhi, Kh., On the basic equations of the theory of thin-walled rods of open cross section in the elastic and plastic ranges (in Russian), *Izv. Akad. Nauk SSSR, Otd. Tekh. Nauk* no. 11, 122–136, 1957.

Author examines basic assumptions made by Vlasov in his theory of thin-walled rods. He starts from the compatibility equations of strains and curvatures and from the equilibrium equations pertaining to cylindrical shells. The latter equations are replaced by three (strains and curvatures versus loading) relationships. The elastic as well as the elastoplastic [Ilyushin, AMR **1** (1948), Rev. 264] cases are considered.

The analysis of the relative order of magnitude of the various strains and curvatures leads to the following conclusions: (1) in case $R^2/L^2 \sim h/R \ll 1$, Vlasov's theory is justified in elastic case if the external forces satisfy, on each straight edge, two given boundary conditions and, over the entire rod, a differential equation. In elastoplastic case the same holds true, but differential equation is more involved. Whenever one of the above conditions is not fulfilled, one must, in general, apply Vlasov's equations for elastic shells of medium length; (2) in case $(R/L)^{4/3} \sim h/R \ll 1$, the "sectorial law" for e_{11} is justified up to and after the elastic limit whether or not the mentioned conditions are satisfied.

Paper supplements studies on the same topic by Gol'denveizer [AMR **4,** (1951), Rev. 1952] and Rabotnov.

G. H. Beguin, Switzerland

5972. Rozovskii, M. I., Stresses in a symmetrically heated spherical shell whose mechanical properties depend on time and temperature, *Soviet Phys.-Doklady* **3,** 3, 667–671, Jan. 1959. (Translation of *Doklady Akad. Nauk SSSR (N. S.)* **120,** 2, 265–268, May–June 1958 by Amer. Inst. Phys., Inc., New York, N. Y.)

A closed spherical shell of uniform thickness, free of surface tractions and residual stresses, is subjected to a temperature change $T(r,t)$ which is a function of radius and time. The thermal coefficient of expansion, Lamé coefficients and relaxation characteristics are also functions of the temperature. The general solution is given in terms of a series of integral equations. The results are considerably simplified, however, when Lamé coefficients are assumed to be

$$\lambda = \mu = \lambda_0 e^{-mT}$$

and the relaxation characteristics are taken to be

$$\phi(t,\tau,r) = \psi(t,\tau,r) = \phi_0(t,\tau)\, e^{-mT}$$

where m is a constant of the material, λ_0 and ϕ_0 are Lamé constant and relaxation coefficient, respectively, at $T = 0$. A hollow sphere subject to a steady-state temperature distribution is used as an illustration.

D. H. Cheng, USA

5973. Grigoliuk, E. I., Stability of nonhomogeneous elasto-plastic shells, *Soviet Phys.-Doklady* **3,** 2, 438–441, Dec. 1958, (Translation of *Doklady Akad. Nauk SSSR (N. S.)* **119,** 4, 663–666, Mar.–Apr. 1958 by Amer. Inst. Phys., Inc., New York, N. Y.)

Purpose of this paper is to analyze the local loss of stability in the elastoplastic range of a bimetallic shallow shell of arbitrary shape under combined loads. The surface of contact of the layers is taken as the fusion and reference surface.

For a solution of the problem, the variations of the stresses in the shell for a pure plastic state, based on the Kirchhoff-Love postulate, are introduced as developed in the author's previous work [*Izv. Akad. Nauk SSSR, Otd. Tekh. Nauk* no. 10, 1957]. Equations of equilibrium and the compatibility conditions are found and relations between stresses and strains have been established. From these expressions it follows that bending and twisting moments as well as normal and shearing forces of the buckled fusion surface depend on: deformation, parameters of change of curvatures and mechanical characteristics of the plasticity of materials. For the finite length of the shell, the equation for the critical loads was developed and specific applications are made to: (a) rectangular plate for finite lengths of the sides and for infinitely wide plate; (b) cylindrical shell under axial compression.

From the general solution it follows that similar formulas can be obtained for a cylindrical shell subjected to lateral pressure and torsion and a spherical shell under external pressure.

This paper presents an extension to the elastoplastic range of the author's previous investigations on bimetallic shells reported in AMR **8** (1955), Revs. 1641, 1951, 3700; AMR **9** (1956), Rev. 437; and AMR **10** (1957), Rev. 2873. It is a valuable contribution to solving difficult problems connected with the buckling of bimetallic shells in the elastoplastic range.

M. S. Troitsky, Canada

5974. Heuck, K., The approximate calculation of the boundary forces of arbitrarily loaded axisymmetric shells (in German), *Beton u. Stahlbeton.* **53,** 11, 280–282, Nov. 1958.

Paper deals with an approximate calculation of boundary stresses for shells of revolution. Noting first the difficulties in the complete solution of the shell problem, the well-known splitting of the problem into membrane and flexure problems is given. Formulas for the boundary stresses for the rotationally nonsymmetric case are given. Retaining then only the highest-order derivatives in the equations of equilibrium, the problem is reduced to the solution of two simultaneous fourth-order equations for deflection and stress function, and the boundary stresses expressed in terms of these. Discussing the order of magnitude considerations necessary for the validity of the above procedure, the solution for the hemispherical shell with antisymmetric loading is given in detail.

G. A. Nariboli, India

5975. Krstić, M., The application of shells of prestressed concrete for the new exhibition hall in Belgrad (in German), *Bauingenieur* **33,** 8, 299–301, Aug. 1958.

Two prestressed concrete shells in the shape of a spherical calotte (R = 56.2 m) on a square planform 48 × 48 m have been built for covering one of the halls for the new fair in Belgrad. The paper gives a short description of these shells and their method of calculation. The membrane theory is applied and stresses calculated for dead weight loading only. The nonlinear differential equation

$$z_{yy}F_{xx} - 2\,z_{xy}F_{xy} + z_{xx}F_{yy} = -Z$$

where $z = z(x,y)$ is the equation of the middle surface of the shell, F the stress function and Z the vertical load, is integrated by choosing for $F(x,y)$ a polynomial of the sixth degree containing two arbitrary parameters. These are determined by Galerkin's method. The stress function is so chosen that the normal force perpendicular to the edges is zero at these edges, so that the supporting edge

beams, which are tied arches, have only to take up the shear force N_{xy}. Tension stresses arise in the vicinity of the four corners of the shell; they are neutralized by placing in these regions a series of parallel prestressing cables directed along the tensional stress trajectories. C. Massonnet, Belgium

5976. Reissner, E., Rotationally symmetric problems in the theory of thin elastic shells, Proc. Third U. S. Nat. Congr. Appl. Mech., June 1958; Amer. Soc. Mech. Engrs., 1958, 51–69.

Paper presents an exhaustive and concise survey of linear and nonlinear theory of rotationally symmetric problems of thin elastic shells. Numerous important contributions to the subject by author and others are summarized with aim of constructing a unified and generalized theory.

Theory of shallow shells of revolution is treated for linear and small nonlinear deflections. Method for closed nonlinear solution of shallow spherical shell is given. In view of examination of applicability of membrane solutions, boundary-layer theory is summarized. Condition for existence of boundary-layer solution is developed for general case, thus generalizing known condition for spherical shell.

Second-order correction theory for influence coefficients of shell loaded on edges only is developed. General condition for negligibility of this correction is given, thus generalizing earlier result of author for cylindrical shell.

Other subjects treated are: Linear theory of pure bending of incomplete shells of revolution, shells of revolution with small variation of radial dimensions, asymptotic solutions for toroidal shells, and bending correction to membrane solution of closed ellipsoidal shell.

Lastly, differential equation of finite bending of thin-walled pressurized tubes of initial circular cross section is set up. Explicit solution is given by series expansion for case of initially straight center line.

Reviewer believes that paper is of major importance in thin-shell theory. Z. Hashin, Israel

5977. Baltrukonis, J. H., Ellipsoidal shells subjected to lateral hydrostatic loading, Proc. Third U. S. Nat. Congr. Appl. Mech., June 1958; Amer. Soc. Mech. Engrs., 1958, 247–252.

The shell is a semi-ellipsoidal shell of revolution and is the head of a fluid-filled horizontal circular cylindrical tank. The derivations are based on Timoshenko's differential equations for the membrane stresses in shells of revolution (where bending stresses are neglected). The result shows compressive stresses over substantial portions of the head, which could cause buckling. The maximum of these compressive stresses is at the boundary of the head. In this region, however, bending stresses will change the membrane stresses. Author expresses the desirability of further investigation with respect to this point.

J. P. Benthem, Holland

5978. Bridgland, T. F., Jr., and Nash, W. A., Elastic deformations of a shallow shell in the form of an elliptic paraboloid, Proc. Third U. S. Nat. Congr. Appl. Mech., June 1958; Amer. Soc. Mech. Engrs., 1958, 265–271.

Elastic deformations of a thin shallow shell in the form of an elliptic paraboloid are investigated by use of the Vlasov equation. For shells with Gaussian curvature zero, these equations are those of Reissner. For readers not familiar with Vlasov's equations it is a pity that it is not mentioned that Vlasov did not start from Love's first approximation. The Vlasov equations are solved in the form of a Volterra integral equation. Final solution is given in series form which it must be hoped is sufficiently convergent. A numerical example shows good convergence.

J. P. Benthem, Holland

5979. Chernykh, K. F., On a variational principle of the complex theory of shells, *Appl. Math. Mech. (Prikl. Mat. Mekh.)* **22,** 2, 320–329, 1958 (Reprint order no. PMM 26, Pergamon Press, 122 E. 55th St., New York 22, N. Y.)

Author presents the solution of the boundary problem of rotationally symmetrical shells with a constant thickness. On the basis of Novozhilov's theory and the fundamental variational equation of shells [Novozhilov, V. V., "Teoriia tonkikh obolochek," Sudpromgiz, 1951], author derives the boundary conditions in a complex form. Derived expressions are valid for Poisson's ratio μ equal zero.

The solution can be applied with advantage to shells of complicated shape since, in the determination of the unknown quantities from the boundary conditions in the place where the shells are joined together, it is not necessary to separate these quantities into their real and imaginary parts.

J. Valenta, Czechoslovakia

5980. Nemenman, M. Z., Torsion of an ovaloid shell (in Russian), *Sb. Nauchno-tekhn. Rabot. Azovo-Chernomorsk. Inst. Mekhaniz. i Elektrefik. S. Kh.* no. 9, 255–257, 1957; *Ref. Zh. Mekh.* no. 5, 1958, Rev. 5710.

It is shown that the function of stresses in the problem of torsion of rollers of variable section

$$\Phi = c\{[(z-a)^2 + r^2]^{3/2} + [(z+a)^2 + r^2]^{3/2}\}$$

appears to be the solution of the problem of torsion of a shell of variable thickness, the surfaces of which are formed by the rotation around axis z of two curves, taken from the family $\Phi = \text{const}$. What is claimed is only true of an open shell (with pieces cut out, excluding from its region axis z), a point overlooked by the author.

K. V. Solyanik-Krassa

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5981. Bunich, L. M., Palii, O. M., and Piskovitina, I. A., Stability of a truncated conical shell, which is under the action of an even external pressure (in Russian), *Inzhener. Sbornik* **23,** 89–93, 1956; *Ref. Zh. Mekh.* no. 5, 1958, Rev. 5715.

The problem is investigated regarding the stability of a shell in the shape of a truncated cone, which is solved by the energetic method. Formulas are prepared for the determination of the critical pressure for a shell with no reinforcement and for a shell reinforced with ribs. A solution is obtained for the full cone which is compared with E. I. Grigolyuk's formula [*Inzhener. Sbornik* **19,** 73–82, 1954]. T. N. Vasitsyna

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

Buckling

(See also Revs. 6107, 6115)

5982. Hoeschel, H. G., Simplified column design, *Mach. Design* **31,** 7, 135–140, Apr. 1959.

Critical stress in straight, axially loaded column members is generally expressed as a function of slenderness ratio and material properties. In design, this relationship is often awkward to apply and usually leads to trial-and-error calculations because the slenderness ratio is not known at the beginning of the solution.

This article presents a simplified, direct approach to column design. Tables and a chart provided here eliminate guesswork in design calculations and, also, give a clearer picture of the effectiveness of specific column materials and cross-sectional shapes.

From author's summary

5983. Chu, K.-H., and Pabarcius, A., Biaxially loaded reinforced concrete columns, Proc. Amer. Soc. Civ. Engrs. **84,** ST 8 (*J. Struct. Div.*), Pap. 1865, 27 pp., Dec. 1958.

A numerical procedure for determining the stress and strain distribution of an arbitrary reinforced-concrete section under combined axial load and bending moments in both directions about the principal axes is developed. The procedure is general and is of particular use in determining the strength in the plastic range.

A numerical example is given. The procedure is cumbersome in general but may be acceptable if high-speed computers are used.

J. A. Cheney, USA

5984. Hanson, N. W., and Reiffenstuhl, H., Concrete beams and columns with bundled reinforcement, *Proc. Amer. Soc. Civ. Engrs.* **84,** ST 6 (*J. Struct. Div.*), Pap. 1818, 23 pp., Oct. 1958.

Tests of pairs of large beams with conventionally spaced and with bundled longitudinal reinforcement are reported. The bundles of reinforcement used comprised groups of four No. 6, four No. 8 or three No. 9 touching bars. Pairs of beams were compared with respect to width of flexural cracks, steel stress distribution, deflection, and ultimate strength. No significant difference in behavior or ultimate strength was found for bundled as compared to spaced reinforcement.

Tied columns were tested by concentric loading to compare spaced and bundled longitudinal reinforcement consisting of twelve No. 6 or twelve No. 8 bars. Comparison with respect to ultimate strength indicated that bundling is a safe detailing procedure when adequate ties are provided, even for 6.6% longitudinal reinforcement. Splicing of bundled reinforcement in columns was explored and found feasible. From authors' summary

5985. Zimmer, A., Numerical procedure for the calculation of generally loaded columns having variable stiffness (in German), *Bauingenieur* **33,** 7, 254–256, July 1958.

Author gives a numerical scheme for the approximate determination of the safety factor in checking the stability of columns. The procedure corresponds to the well-known graphical iterative method developed by Vianello, and is based on it.

A. Werfel, Israel

5986. Haythornthwaite, R. M., and Boyce, W. E., The load-carrying capacity of wide beams at finite deflection, Proc. Third U. S. Nat. Congr. Appl. Mech., June 1958; Amer. Soc. Mech. Engrs., 1958, 541–550.

Authors treat problem of post yield-carrying capacity of centrally loaded rectangular plate, clamped at two opposite edges and free at others. It is assumed that deformations at ultimate stage are large enough to permit analysis by membrane theory only; that geometric configuration is a radially symmetric deflection in plasticized region near the load and pure rigid rotation of elastic plate domain outside. Assumed mechanism is accordingly a combination of mechanisms previously used for limit analysis of circular plates and of narrow beams. Authors also give account of deflection measurements performed on steel plates of varying breadth/length ratio loaded beyond yield point. These prove the practical value of their solution. Reviewer believes that further experimental evidence is required to fully justify authors' simplified approach to this very complex problem. Z. Hashin, Israel

5987. Kotowski, G., On the behavior in the elastic range of slender bars and thin plates of constant cross section under varying axial load (in German), *Dtsch. Versuchsanstalt Luftfahrt Ber.* 68, 62 pp., Nov. 1958.

A survey is given of work published during the past twenty-five years, generally in the field described in the title. The exact extent of this survey will not be summarized here. However, the survey covers the work of many well-known papers in the field, and includes, for example, work on dynamic instability.

H. G. Hopkins, England

5988. Pian, T. H. H., Creep buckling of curved beam under lateral loading, Proc. Third U. S. Nat. Congr. Appl. Mech., June 1958; Amer. Soc. Mech. Engrs., 1958, 649–654.

Variational theorem for creep is applied to the problem of creep deflection of a curved beam under lateral loading. The ends of the beam are restrained from sliding motion, hence under a static load it is possible for it to buckle suddenly from one equilibrium condition to another. It is shown that this abrupt buckling may also occur under the action of creep deformation. Both viscoelastic and nonlinear creep properties are included in the analysis.

From author's summary by J. M. Alexander, England

5989. Donnell, L. H., Effect of imperfections on buckling of thin cylinders with fixed edges under external pressure, Proc. Third U. S. Nat. Congr. Appl. Mech., June 1958; Amer. Soc. Mech. Engrs., 1958, 305–311.

Buckling of imperfect thin fixed-edge cylinders under uniform external pressure is treated by energy method previously used [AMR **10** (1957), Rev. 2498] by author for case of hinged-edge cylinders under similar loading. Finite deflection theory is used. Imperfections are lumped into an equivalent deviation from perfect cylinder, and formula for amplitude of deviation is taken from previous papers. Deviation and buckling mode are assumed to have same shape and are taken in a form containing two undetermined parameters and an arbitrary number of circumferential waves.

Solution of differential equations in terms of wave number and deflection parameters permits the expression of strain energy in terms of these quantities, and law of virtual work leads to three nonlinear algebraic equations in equivalent parameters. These are solved by a somewhat inverse method using results of previous hinged-edge solution to reduce amount of computation. On this basis it is indicated that postbuckling resistance does not drop off, so that peak resistance is determined by onset of yielding at highly stressed points. Results appear to be consistent with tests if reasonable range of imperfections is postulated.

J. E. Goldberg, USA

5990. Vidman, D. N., The stability of shape of turbine shafts and rotors at high temperatures (in Russian), Strength of metals, Moscow, Akad. Nauk SSSR, 1956, 67–80; *Ref. Zh. Mekh.* no. 5, 1958, Rev. 6066.

Results are given of the investigations on the inadequate stability of turbine shafts, rotors and other components: the residual changes of the regular geometrical shape of the components and thermal instability. Some recommendations are made to prevent and eliminate the instability. From author's summary

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5991. Nariboli, G. A., Mixed boundary-value problems for rectilinear plates, Part II (in English), *Arch. Mech. Stos.* **10,** 2, 129–142, 1958.

For Part I see AMR **11** (1958), Rev. 3954.

Solutions are developed for buckling and vibration of flat plates having straight-line boundaries. All edges but one are assumed as simply supported; the remaining edge is taken as built-in along at least a portion of its length with the remaining portion being simply supported. The buckling load is a two-dimensional "hydrostatic" compression load.

The unknown reaction moment along the built-in boundary segment is determined by an influence-factor approach. Detailed results are given for two specific triangular plates.

E. J. McBride, USA

5992. Jojic, K. V., The buckling of a reinforced rectangular plate (in English), 9th Congrès Intern. Mécan. Appl., Univ. Bruxelles, 1957; **7,** 56–69.

Buckling of a rectangular flat plate reinforced with equidistant longitudinal and transverse ribs is presented. General equations are derived for any number of ribs in either direction with a uniform compression in the middle plane of the plate. The deflection equation is given in the form of a Fourier series and the critical

load is determined by successive approximations. Numerical examples illustrate the importance of the number of ribs on the value of buckling load and the dependence of accuracy on the ratio of spacing between longitudinal and transverse ribs.

J. D. Marketos, USA

5993. Baltrukonis, J. H., Thermal buckling of hinged plates (in English), 9th Congrès Intern. Mécan. Appl., Univ. Bruxelles, 1957; **7,** 13–20.

The plate is considered to be infinitely wide and is of length λ between the hinges. The title problem is solved by considering first that the plate of length λ is free and is increased to length λ_t on heating and then the increased plate of length λ_t is compressed to its original length λ by compressive thrust. Thermal buckling strain is obtained from the critical buckling load due to compression of the plate of length λ_t, the latter however being determined from the solution of the problem of buckling of struts. The shape of the buckled plate for a given temperature differential is also obtained. D. N. Mitra, India

5994. Yoshiki, M., Yamamoto, Y., and Suzuki, T., Axisymmetric collapsing of circular cylindrical shells of submarines (in Japanese), *J. Soc. Nav. Arch., Japan* **105,** 115–125, July 1959.

Collapsing of circular cylindrical shells under external pressure has been investigated in relation to the strength of pressure hulls of a submarine. Cylindrical shells collapse by causing shell yielding when they are reinforced closely by circular frames. This phenomenon takes place suddenly with a loud noise, and it seems therefore to be a sort of buckling accompanied by large plastic deformations. If shells are made literally in a circular form, the collapsing pattern will be axially symmetric; hence, such collapsing should be called axisymmetric collapsing rather than shell yielding.

Axisymmetric collapsing was investigated by Sanden-Günther and Trilling. Their theories are based on an assumption that shells will collapse as soon as the stress condition reaches a certain state. The behaviors of shells are different from those expected by these theories, and there follows even a marked discrepancy between experiments and the theory of Sanden-Günther.

In this paper a rational theory is developed on the basis of the theories of plasticity and buckling; the validity of this theory was confirmed by experiments. When the sectional area of frames is comparatively small, collapsing occurs over three frame spaces; and when large enough, between two consecutive frames.

From authors' summary by T. Kanazawa, Japan

Vibrations of Solids

(See also Revs. 5867, 5903, 5991, 6017, 6033, 6296, 6300)

5995. Feller, W., On the equation of the vibrating string, *J. Math. Mech.* **8,** 3, 339–348, May 1959.

This is a presentation of a generalized equation for the vibrating string. The equation is $\Omega u = u_{tt}$, where Ω is a linear operator (independent of t) of local character with the positive maximum property. This means that $\Omega f(s) \leqslant 0$ at each point, where f reaches a positive maximum.

The generalized equation leads to a unified but highly abstract theory for all cases covering discontinuously varying masses and elastic forces. A. I. van de Vooren, Holland

5996. Hieke, M., Contribution to the forced vibration of membranes (in German), *ZAMM* **38,** 9/10, 356–368, Sept./Oct. 1958.

The inhomogeneous differential equation for a vibrating circular membrane with fixed boundary is solved when the force is a step-function of axial symmetry. For this purpose use is made of Weber's equation for the Bessel function of zero order. The case of static as well as that of periodic force is then treated with the help of well-known integral theorems.

By a superposition of forces of the kind here chosen most cases of axial symmetry that are of practical importance can be represented. Some of these cases are mentioned.

From author's summary by J. L. Lubkin, USA

5997. Greenspon, J. E., Flexural vibrations of a thick-walled circular cylinder, Proc. Third U. S. Nat. Congr. Appl. Mech., June 1958; Amer. Soc. Mech. Engrs., 1958, 163–173.

Author's paper is an extension of earlier work by others on vibrations of infinitely long solid cylinders and thin shells with given end conditions. The frequency equation for flexural vibrations of a thick-walled cylinder kept circular at its ends is obtained using three-dimensional theory of elasticity formulations. Numerical results for various parameter ranges were calculated using an automatic digital computer. Curves of frequency as a function of length and thickness ratio are given. Results indicate that frequency is very insensitive to the thickness ratio for beam-type vibrations. Contrariwise, frequency is very sensitive to the thickness ratio for the lobar mode.

Author's work establishes a foundation for further study and checking existing shell theories. R. B. Grant, USA

5998. Bishop, R. E. D., The vibration analysis on nonuniform beams and systems containing them (in English), 9th Congrès Intern. Mécan. Appl., Univ. Bruxelles, 1957; **7,** 388–394.

Paper is an extension of the use of receptances [AMR **8** (1955), Rev. 1280] to the vibration analysis of systems which contain beams of nonuniform cross section. Specifically, author explains a method for finding the receptance of a nonuniform beam.

R. E. Beckett, USA

5999. Mahalingam, S., An improvement of the Myklestad method for flexural-vibration problems, *J. Aero/Space Sci.* **26,** 1, 46–50, Jan. 1959.

Author presents a method of obtaining the next approximation for the natural flexural frequency of a nonuniform beam, using an auxiliary calculation based on the results of a Myklestad table. As in Myklestad method, a nonuniform beam is represented by a set of point masses connected by light elastic beam segments. Method presented is based on the change in natural frequency resulting from a (ficticious) change in mass of one point mass, or in stiffness of one beam segment. Advantage lies in rapid convergence of successive approximations. Several end conditions are treated. An illustrative numerical example is given.

J. C. Truman, USA

6000. Ziemba, S., The influence of mass and internal friction on free torsional vibrations of a bar (in English), *Arch. Mech. Stos.* **9,** 1, 51–70, 1957.

The vibration of a torsional pendulum is analyzed for the simple system having one degree of freedom and for the exact system having an infinite number of degrees of freedom.

The differential equation of the simple system is presented in two forms: (a) without damping; (b) with the combined internal friction and external drag. An energy method is used to approximate the influence due to the mass of the torsional element.

The exact treatment separates the internal friction and external drag, and considers the torsional element as being a continuously varying body of revolution. The resulting equation is solved for the free vibration of a cylindrical torsional element. Several boundary conditions are covered in the solutions.

The article represents a rigorous mathematical extension of the theoretical basis frequently used to determine the shear modulus and internal friction of a material. H. Faught, USA

6001. Pister, K. S., Flexural vibration of thin laminated plates, *J. Acoust. Soc. Amer.* **31,** 2, 233–234, Feb. 1959.

Treatment of title problem is straightforward within classical plate theory (Poisson). Result (vibration of equivalent homogeneous plate) is not startling, but of potential value for reference purposes. Eq. [4c] seems to be a misprint. Inplane motion and lateral motion are not completely uncoupled; this is due to arbitrary choice of variables and could be remedied easily.

E. F. Masur, USA

6002. Carmichael, T. E., The vibration of a rectangular plate with edges elastically restrained against rotation, *Quart. J. Mech. Appl. Math.* **12,** 1, 29–42, Feb. 1959.

The edges of the plate are rigidly supported against displacement, but elastically restrained against rotation and opposite pairs restrained to the same degree. The Rayleigh-Ritz method is used and author builds up a suitable waveform by means of the characteristic functions of a beam whose ends are elastically restrained against rotation; the waveform can be made to satisfy the boundary conditions term by term. A frequency determinant is found, and as the diagonal elements are much greater than the off-diagonal terms, the characteristic values can be determined by an iterative process. Many numerical results are given and the accuracy of the solution is discussed.

O. Bottema, Holland

6003. Dill, E. H., and Pister, K. S., Vibration of rectangular plates and plate systems, Proc. Third U. S. Nat. Congr. Appl. Mech., June 1958; Amer. Soc. Mech. Engrs., 1958, 123–132.

This paper, which is based upon part of the first author's thesis, considers the free and forced vibration of flat systems of rectangular plates. The middle surface deflection of each plate is expanded in Fourier series. As examples the natural frequencies are determined for single plates under various boundary conditions. For plate systems a seven-moment equation is formulated, equivalent to the three-moment equation that can be used in the analysis of continuous beams. The method is limited to systems of plates of which the corners do not deflect.

M. Botman, Canada

6004. Raskovic, D., Transverse vibrations of a triangular plate with damping (in French), 9th Congrès Intern. Mécan. Appl., Univ. Bruxelles, 1957; **7,** 478–484.

Small transverse vibrations of a homogeneous and isotropic triangular plate built-in at one end and free at the other are considered when damping proportional to the velocity is acting. After removal of the damping term by a standard transformation the method of Galerkin is used to find the natural frequencies.

E. Saibel, USA

6005. Karyakin, N. I., The vibrations of thin-walled bars (in Russian), *Zb. Nauchn. Rabot. Vyssh. Shokla Promysl. Kooperatsii* no. 2, 3–34, 1957; *Ref. Zh. Mekh.* no. 2, 1958, Rev. 2111.

Methods are described for the calculation of thin-walled bars exposed to vibration, both for the mathematical analog between the problems of constrained torsion and longitudinally-lateral bending, and for the principle of the minimum. The problems examined concern the free, torsional vibrations of bars of constant cross section with a continuous distribution of the masses, and the torsional and flexural-torsional vibrations of bars, including bars under eccentric compression.

A. K. Mroshchinskii

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6006. Bezukhov, N. I., and Luzhin, O. V., The analysis of thin-walled bars under constrained vibration (in Russian), Researches on the theory of structures, no. 7, Moscow, Gosstroiizdat, 1957, 7–41; *Ref. Zh. Mekh.* no. 2, 1958, Rev. 2113.

The constrained vibrations of thin-walled bars are investigated. It is found that, under the action of a dynamic load, the influence of constraint in the coplanar displacement of the cross sections of thin-walled bars is greater than under static load. The analysis is applied to the constrained torsional vibrations of thin-walled bars with two axes of symmetry. In such case, the bending vibrations are expressed by the known equations in the theory of vibration of nonthin-walled bars; then the equations of the torsional vibrations can be sufficiently described by a single differential equation. For the solution of this equation, authors use the method of initial parameters, for which the paper gives the ultimate expressions for any cross section and a table of amplitudes of the vibrational reactions for particular, concrete cases of constraint of the bar. As an example, a double-tee beam is examined with a concentrated torsional moment applied at the middle of the span. It is found that the constraint of the coplanar displacement decreases the binary moment at the center of the span by more than half, while the torsional moment at the support is reduced by 30%. For comparison, the paper includes amplitude curves obtained when the same double-tee is analyzed as a nonthin-walled bar.

Further, the free, torsional vibrations are examined of thin-walled bars whose cross section has two axes of symmetry. In this case, the equations of the constrained torsional vibrations must contain the value of the external perturbation equal to zero, and the frequency of constrained vibration must be replaced by the natural frequency. Further, the problem is discussed of the constrained torsional bending vibrations of thin-walled bars, whose cross section has a single axis of symmetry. The corresponding formulas and tables of the amplitudes of the initial parameters are in this case more complicated. As a result of the comparison between the curves of the force and amplitude for the case of a thin-walled section, it can be stated that under the action of concentrated forces of equal value, the torsional factors are considerably smaller than for the action of a vibrating torsional moment of the same frequency; and conversely, the bending factors in the second case, are small compared with the bending factors in the first case. The influence of concentrated masses on the amplitudes of constrained vibration are examined for the case of a longitudinal force resulting from an elastic moment. Finally, the particular features are examined of the calculation of compound bars of thin-walled elements; in particular, bars with a discontinuous axis. The paper introduces the conception of a "dynamic center of rigidity," having the particular property that the dynamic transverse load passing through it does not cause torsion of the bar.

D. V. Byichkov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6007. Carnegie, W., Vibrations of pre-twisted cantilever blading, Instn. Mech. Engrs., Prepr., 22 pp., 1958.

Author presents results of analytical and experimental study of effects of pre-twist on natural frequencies of cantilever beams, with view to application to turbomachinery blading analyses. Blades are assumed to have uniform cross section, and pre-twist is assumed linear.

Equations of motion for the blade are derived; however, analysis is based on Rayleigh's energy method. Expressions are derived for lateral and torsional (for airfoil sections, coupled) natural frequencies for straight and pre-twisted blades of rectangular and airfoil cross sections. Expression is derived for increase in torsional stiffness due to pre-twist.

Author describes test set-up, and presents data as graphs of torsional stiffness and natural frequencies versus pre-twist angle. Agreement with theory is generally good. Frequency range of approximately 20 to 5000 cps, and pre-twist angles from 0 to $\pi/2$, are covered. Nodal pattern diagrams are given.

Effects of pre-twist are found to be, in general, significant. Reviewer notes that author's assumption of uniform cross section limits direct use of results for some applications.

J. C. Truman, USA

6008. Dabagyan, A. V., Vibrations of the blade assembly of a turbomachine, induced by unsymmetrical currents in the generator (in Russian), *Vestn. Elektroprom-sti* no. 7, 18–22, 1957; *Ref. Zh. Mekh.* no. 5, 1958, Rev. 6061.

Experiments are described for studying the influence of the transitional work of a generator during vibrations of the turbine blades. The experiments were carried out on a dynamic model by the energetic system. The deformations were measured by resistance-wire strain gages. An investigation was carried out on the influence of the impact change of output, through the directing apparatus of the turbine, on the creation of transitional processes in the system and also an investigation of the blades' vibration during the transitional processes in the electrical part of the system. In the first case the gages were fixed on the neck of the shaft between the rotor of the generator and the turbine; in the second case the gages were fixed on a blade of the turbine. In order to obtain a clearly defined nonsymmetry of the current the investigation was made with a two-phase short circuit. For the purpose of eliminating the influence of the turbine regime and the impulses appearing as the result of the short circuiting, the experiment was repeated with a three-phase short circuit. It was established as the result that an unsymmetrical change of the regime of loading on the generator's rotor may be the cause of the oscillations of the blades on the rotor of the turbine. A. D. Pospelov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6009. Lyssenko, B. M., The vibrational analysis of bundles of rotating blades (in Russian), *Sb. Trudĭ Labor. Gidravl. Mash., Akad. Nauk USSR*, no. 6, 180–191, 1956; *Ref. Zh. Mekh.* no. 2, 1958, Rev. 2253.

An approximation method is described for determining the frequency of vibration of rotating, shrouded blades. By applying the theorem of d'Alembert a differential equation is obtained for the transverse vibrations, which is then solved for a singly-shrouded blade of constant cross section. The solution of the resulting equation is sought in the form of a series expansion by fundamental functions for a cantilever bar. This leads to equations determining the frequency of vibration of the blade in the first and second modes, with allowance for the centrifugal forces, bending moment, transverse force, and the inertia of the shroud. A numerical example is given for a steam-turbine blade.

A. S. Ginevskii

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6010. Federhofer, K., Vibration of a circular arch pivoted in both ends and loaded with a periodically varying force (in German), *Öst. Akad. Wiss. Math.-Nat. Kl. S. B.*, Abt. II, **166,** 6/10, 125–137, 1957.

Author gives a mathematical analysis of forced vibrations of an arc by a vertical pulsating force. The investigation assumes that the arc has a circular axis, the girder is of constant cross section, hinge-supported about the line of symmetry. The equation of motion of a point on the arc is written in Lagrangian form, and tables showing results of the arc suspended on openings varying from $2\alpha = 0$ to $2\alpha = \pi$ are given, α being the angle on each side of the line of symmetry of the arc. M. Maletz, USA

6011. Terenin, B. M., Vibrations of round arches (in Russian), Investigations in the theory of constructions, no. 7, Moscow, Gosstroiizdat, 1957, 43–61; *Ref. Zh. Mekh.* no. 5, 1958, Rev. 5763.

An approximate method is proposed for the calculation of round arches of constant section. The arches are considered as systems possessing two steps of freedom. The basis of the calculation rests on the mixed method for the structural mechanics of rod systems. The differential equations of the problem are described as symmetrical, and the natural vibrations of the arch as antisymmetrical. To ascertain the frequencies and the first two forms of vibrations of three-, two-hinged and no-hinge arches formulas are derived through the determinant of the system; these are given in a special table. Other tables are also drawn up to facilitate the determination of the transpositions and bending moments in the joints of the arch, which appear as apexes of a broken line, by which the curvilinear axis of the arc is replaced. The number of sections replaced by the broken line is taken to be equal to six.

A. I. Oseled'ko

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6012. Conway, H. D., An analogy between the flexural vibrations of a cone and a disc of linearly varying thickness (in English), *ZAMM* **37,** 9/10, 406–407, Sept./Oct. 1957.

When Poisson's ratio (for disk) is ⅓, vibration equations for two subject cases become similar. Author gives natural frequencies and compares to solution for disk of constant thickness.

G. A. Nothmann, USA

6013. Stollmayer, A., Vibration phenomena in hydraulic structures (in Hungarian), *Hidrológiai Közlöny* **38,** 4, 282–289, Aug. 1958.

6014. Eringen, A. C., Response of tall buildings to random earthquakes, Proc. Third U. S. Nat. Congr. Appl. Mech., June 1958; Amer. Soc. Mech. Engrs., 1958, 141–151.

A method of analysis is given for the calculation of mean square displacements and various correlation functions for a tall building having an arbitrary number of stories. The building is approximated by a series of masses and dashpots, and it is assumed that the mean square displacements of the earth movements are known. Mean square shearing forces and the energy present at each story are evaluated. It is indicated that Rice's formula may be used to calculate the number of times per unit time a random variable (e.g., displacement) will exceed a known, safe value. Computations concerning a ten-story building subject to a purely random earthquake process were carried out on an electronic computer and are plotted.

From author's summary by G. P. Fisher, USA

6015. Takeda, S., Vibrations of a car taxiing on a road (in Japanese), *Monthly Rept. Transportation Tech. Res. Inst., Japan* **8,** 6, 1–16, Jan. 1959.

A technique for analyzing vibrations and loads of a car taxiing on a road, based upon the theory of random process, is developed. Following basic assumptions are made: (1) Variation of the road height is a stationary random process, (2) the model representing the car vibration is a linear system, and (3) the car is assumed to be rigid and to have freedoms of vertical translation, pitching and rolling. The unsprung wheel masses of the car are assumed to move only vertically. Under these assumptions, the power-spectral-densities of the vibration amplitude and dynamic loads during taxiing are determined. Lastly, a life expectancy of the car in taxiing is discussed and a method for estimating life expectancy is proposed.

From author's summary by K. Washizu, Japan

6016. Sperling, E., and Betzhold, Ch., Vibrational and strength investigations of railway cars (in German), *Öst. Ingenieur Z.* **1,** 11, 473–481, Nov. 1958.

6017. Kumai, T., On the virtual inertia coefficients of the vertical vibration of ships (in Japanese), *J. Soc. Nav. Arch., Japan* **105,** 219–227, July 1959.

An investigation is made of the virtual inertia coefficients of the vertical vibration of ships by means of the strip method, taking

the effects of virtual rotatory inertia of the water and the three-dimensional motion into account. In the present investigation, the results of vibration measurements on a wooden model of a tanker are analyzed. For estimating the three-dimensional correction factors of the virtual inertia coefficients of the vertical vibration of ships, experimental studies on the vibration of cylindrical solid models having several kinds of sectional forms are carried out and the results are taken into account. The analyses of the three-dimensional motion of the circular and elliptic cylinders on water, and experimental studies of the measurements of the virtual inertia coefficients of the vibrations of the solid beams and a tanker model are presented in Appendices I and II, respectively.

From author's summary by T. Inui, Japan

6018. Naerlovich, Natalija, Numerical methods of computing vertical vibrations of ships' hulls, *Inter. Shipbldg. Progr.* **5,** 44, 151–162, Apr. 1958.

Paper presents a numerical method for determining vertical forced vibrations of ships' hulls. The method consists in substituting for the integral equation of forced vibrations a system of linear algebraic equations. The method is compared with that given by A. N. Krylov in a Russian book on differential equations, which is based on a numerical integration of the differential equation of forced vibrations.

Reviewer's comment: Differential equation does not include shear or rotary inertia and is applied to a beam symmetrical about the half length. Numerical work appears about equivalent to that of Prohl-Mykelstad method but, being a mathematical method, the advantage of a direct physical connection to the problem is lost.

F. E. Reed, USA

6019. Kartava, A. I., Experimental investigation on the necessity to reduce the moments of inertia of the sectional areas of the longitudinal bonds of the stern end of ships and the effect of such reduction on the general and local vibration of the hull (in Russian), *Trudi Nikolaevskogo Korablestroit. In-ta* no. 10, 3–44, 1957; *Ref. Zh. Mekh.* no. 5, 1958, Rev. 5959.

A description is given of experimental investigations carried out by the author on the vibration of thin-walled tubes intended to reproduce the stern section of a ship. Based on the results of these investigations, a recommendation is put forward to the effect that when calculating vibration at the stern of the ship its rigidity should be evaluated with a reduction coefficient for $\varphi = 0.38–0.50$.

Yu. A. Shimanskii

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6020. Arsyntkin, A. A., Calculations for the forced vibrations of the decking of a ship's hull (in Russian), *Sudostroenie* no. 3, 11–17, 1957; *Ref. Zh. Mekh.* no. 5, 1958, Rev. 5960.

When investigating resonance vibrations of elastic systems it is customary practice to take into account only the forces of internal inelastic resistance of the material. However, with vibrations in these systems, such as in ship decks and hull plating, the prevailing influence is exerted by forces of external resistance (water and atmosphere) and by forces due to dissipation of energy in the intermediate constructions of a ship hull. The experimental determination for the coefficients of absorption of energy in ship decking is described; this is done by means of special pontoon imitating the actual decking of the ship. The results of the experiments are incorporated in recommendations for the numerical values of these coefficients. A method is also submitted, based on the principal coordinates, for the calculations of resonance vibrations of typical ship decking which make their appearance as the result of the general vibrations in the ship hull when the ship is in motion.

Yu. A. Shimanskii

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6021. Gontkevich, V. S., The influence of certain factors on the damping properties of the principle materials used in turbine construction in the presence of bending vibrations (in Russian), *Sb. Trudi Labor. Gidravl. Mashin., Akad. Nauk USSR* no. 6, 192–202, 1956; *Ref. Zh. Mekh.* no. 2, 1958, Rev. 2346.

The problem is discussed of the influence of heat-treatment, work-hardening (in plastic bending) and increasing the temperature to 600° on the dissipation of energy in the principal steel grades used in turbine construction. Data obtained by the author are presented on the change in the relative dynamic modulus of elasticity against temperature for these materials.

V. V. Khil'chevskii

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6022. Lowe, R. T., Practical considerations involved in shock and vibration isolation, *Noise Control* **4,** 2, 53–57, 75, Mar. 1958.

6023. Buscarello, R. T., A practical approach to vibration and balancing problems in machine maintenance, ASME-Maintenance & Plant Engng. Conf., Pittsburgh, Pa., Apr. 1958. Pap. 58-MPE-5, 9 pp.

6024. Rule, E., Suellentrop, F. J., and Perls, T. A., Optical method for measurement of vibration amplitudes, *Rev. Sci. Instrum.* **30,** 1, 40–41 (Notes), Jan. 1959.

6025. Dieckmann, D., A mechanical-vibrational model of the vibrationally excited hand-arm-system of a human (in German), *Z VDI* **101,** 1, 23–26, Jan. 1959.

6026. Ostroumov, G. A., On the self-excitation of wall auto-oscillations in a fluid-carrying channel, *Soviet Phys.-Tech. Phys.* **3,** 6, 1130–1134, Feb. 1959. (Translation of *Zh. Tekh. Fiz., Akad. Nauk SSSR* **28,** 1215–1219, June 1958 by Amer. Inst. Phys., Inc., New York, N. Y.)

Author explains the periodic auto-oscillations of the channel walls in which a fluid is flowing by means of the hypothesis of Jeffreys in regard to periodic pressure, $\Delta p = -Rv$, which is phasewise in opposition to the normal component of the velocity. The case of a vibrating wall is described by a superposition of two waves moving relative to the fluid flow with different velocities. Comparing the power delivered by the flowing fluid with the viscous dissipation author deduces the self-excitation condition. Equating for small auto-oscillations the average potential energy to the average kinetic energy of the system, consisting of the mass of the plate and of the mass of the liquid associated with the oscillations, author shows that the inertia of the wall is negligible compared to the inertia of the oscillating water. Assuming that the wall of a channel or of a floodgate valve is made in the form of a framework the frequency equation is obtained and the region of velocities and viscosities in which self-excitation of auto-oscillations is possible is drawn. Author concludes that the subject matter of this paper might serve as a basis for the experimental determination of the pressure coefficients for water.

D. Raskovic, Yugoslavia

Wave Motion and Impact in Solids

(See also Revs. 5885, 6070, 6071, 6072, 6119, 6241)

6027. Cole, J., and Huth, J., Stresses produced in a half plane by moving loads, *J. Appl. Mech.* **25,** 4, 433–436, Dec. 1958.

The stresses and displacements caused by a line load moving at a constant speed along the surface of an elastic half plane are a starting-point for the solution of all analogous problems which lead to plane strain distributions. Authors therefore treat in de-

tail this fundamental question regarding the three different cases which are possible with respect to the ratios of the speed of the load to the longitudinal and transversal wave speeds of the elastic medium. Respectively, the differential equations are formulated and solved and the results are plotted graphically.

F. Engelmann, Germany

6028. Maryamova, F. A., An investigation of the wave nature of the differential equation for the transverse oscillations of a beam (in Russian), *Sb. Trudī Mosk. Zaochn. Poligr. In-ta* no. 5, 169–175, 1957; *Ref. Zh. Mekh.* no. 2, 1958, Rev. 2108.

It is found that the Timoshenko equation, which considers the displacements and rotational inertia of the cross sections, leads to two values of the velocity of propagation of the perturbations:

$$c_1 = \sqrt{E/\rho}; \qquad c_2 = \sqrt{kG/\rho}$$

At the same time, the simplified equation of the transverse vibrations indicates the possibility of propagation of the perturbations with an infinite velocity. These conclusions are not new, having already been obtained by Ya.S. Uflyandom [*Prikl. Mat. Mekh.* **12**, no. 3, 1948].

V. L. Biderman

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6029. Petrashen', G. I., Methods of construction for problems of the propagation of seismic waves in isotropic media containing plane-parallel layers of considerable thickness (in Russian), Problems of the dynamic theory of the propagation of seismic waves. I, Leningrad, Gostoptakhizdat, 1957, 7–69; *Ref. Zh. Mekh.* no. 2, 1958, Rev. 2094.

The formulation of problems concerning the propagation of seismic waves in laminated media is discussed. Methods are proposed for the construction of solutions in the presence of an arbitrary arrangement of the points of observation and sources of a varying character (both symmetrical and unsymmetrical); the auxiliary formulas necessary for this construction are presented. Methods are indicated for generalizing the results obtained for the case of a viscoelastic medium, as well as a medium with elastic hysteresis.

K. I. Ogurtsov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6030. Abgarin, K. A., The theory of the longitudinal impact of elastic bars (in Russian), Trudī MAI no. 43, 54–80, 1955; *Ref. Zh. Mekh.* no. 2, 1958, Rev. 2097.

An examination of the fall of an absolutely solid body on the free end of a vertically erected, homogeneous elastic bar the lower end of which is rigidly constrained. The transverse (shear) displacements of the particles of the bar are disregarded. The problem is solved fully up to the instant of rebound of the falling body. In principle, no new results are presented. In explaining the "physics" of the phenomenon, author makes the erroneous statement that, in the case of reflection from the fixed end, the compression wave becomes an extension wave (see end of p. 74).

N. F. Lebedev

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6031. Volarovich, M. P., and Balashev, D. B., An investigation of the velocity of propagation of elastic waves in rock samples at pressures up to 5000 kg/cm² (in Russian), *Izv. Akad. Nauk SSSR, Ser. Geofiz.* no. 3, 319–330, 1957; *Ref. Zh. Mekh.* no. 2, 1958, Rev. 2207.

It is pointed out that, with increasing depth, the rate of propagation of elastic waves in rocks also increases, in view of the pressure of superincumbent strata; and that, consequently, laboratory tests on the elastic properties of rocks are necessary, conducted at high pressures, since ignorance of these facts inevitably causes gross errors in the evaluation of seismic observations. A method and a technique are described for measuring the velocities of elastic waves in rock samples under multilateral compression at pressures up to 5000 kg/cm², corresponding to depth of strata of the order of 20 kilometers, i.e. depths at which earthquake foci arise. The rock samples together with two supersonic, piezoelectric gages, one of which acts as the transmitter and the other as the receiver, are placed in a thick-walled steel bomb into which nitrogen is introduced under the required pressure. Measurements have been made at a constant temperature (20°). Excitation and reception of the supersonic vibrations was effected by a BI-4 impulse seismoscope, developed by the Geophysical Institute of the Akad. Nauk SSSR. The oscillograms were recorded by photographing the screen image with an electronic radiation tube connected to the vibration receiver. The frequency of emission of the impulses was 2–50 c/s. A detailed description of the experimental apparatus is given, as well as of the experimental method. To protect the samples from the penetration into their pores of the pressure-generating medium, they were hermetically sealed in copper foil. Investigations were made on cores of basalt, dolomite and syenite, resulting in the discovery of abrupt increases in the velocity of longitudinal waves with increasing pressure from 500 to 1000 kg/cm², after which the increase in velocity becomes slower, which is due to closing of the pores in the rock. The general increase in velocity at a pressure of 5000 kg/cm² was 10–12% for basalt and dolomite, and ~ 20% for syenite.

K. K. Glazenap

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6032. Chekanov, A. N., An investigation of the mechanical properties of materials in torsional impact (in Russian), Strength calculations in mechanical engineering, Moscow, Mashgiz, 1955, 206–227; *Ref. Zh. Mekh.* no. 2, 1958, Rev. 2348.

By means of an arrangement incorporating a tup and an oscillograph, the change in the mechanical properties of materials exposed to torsional impact has been investigated in relation to the change in the rate of deformation. Curves are presented of the influence of the deformation rate on the ultimate strength and the ultimate relative shear deformation of Steel 30; a description is given of the nature of failure in Bronze OTS and cast iron. The stress-deformation relationship, which at high rates of deformation in steel approaches the characteristics of the ideally-elastic material, corresponds in form to a rectangular pulse, the undistorted transmission of the flat part whereof requires a maximum expansion of the amplifier pass-band in the region of low frequencies. It is also necessary to have a sufficiently high top frequency limit. Independent of the width of the amplifier pass-band, the form of the pulse requires correction in accordance with the transient amplifier characteristic.

M. L. Zaslavskii

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6033. Chirkov, Ya. N., The action of instantaneously appearing and instantaneously disappearing loads (in Russian), Investigations in the theory of constructions, no. 7, Moscow, Gosstroiizdat, 1957, 111–120; *Ref. Zh. Mekh.* no. 5, 1958, Rev. 5765.

Based on the solution of the problem of the vibrations of an infinitely long beam, to which a concentrated force is suddenly applied, the case in investigated of the action of instantaneously appearing and instantaneously disappearing loads on a beam of finite length. The infinitely long beam is loaded with forces in such a fashion that any finite portion of its length, located between specially selected sections, can be examined as a freely supported beam, for which the solution of the problem of vibrations is obtained from the solutions for the infinitely long beam by the method of superposition. A detailed investigation is made for the case of the momentary action of an evenly distributed load; the period of action of the load is found from the formula $\Delta t = T_1/2^n$, where T_1 is the period of the basic tone of the free vibrations, n

being taken to be successively equal to 1,2, ... This gives a general picture of the changes in the bending moments in the sections of the beam in relation to time. From the deductions emerging from the study, author is led to explain the appearance, when the brittle beams collapse, of cracks not in the central sections (as expected) but in the sections nearer the supports.

A. I. Oseled'ko

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6034. Ezra, A. A., The plastic response of a simply supported beam to an impact load at the center, Proc. Third U. S. Congr. Appl. Mech., June 1958; Amer. Soc. Mech. Engrs., 1958, 513–520.

Under assumption of the rigid-plastic idealization of material properties the centrally acting impact on a simply supported beam is studied. Author presents very clear and useful description of an idealized model of beam behavior based on the possibility to divide, during the impact, the span length of the beam into a middle V-shaped portion connected with the rest by moving plastic hinges. The elastic behavior of the beam may be neglected, the kinetic energy of impact being large in comparison to the strain energy the beam can store elastically.

The differential equations of motion are developed and discussed. The agreement of experimental and numerical results is found to be very good even in the region of high-speed impacts when the effect of increased yield moment due to high rates of strain is included.

Paper is very well written, easy to follow and, in reviewer's opinion, may be regarded as an excellent example of how to deal with a complicated problem using its exactly defined and clear idealization without application of cumbersome mathematical methods.

K. Julis, Czechoslovakia

6035. Borodachev, N. M., Some problems of the analysis of continuous mechanical linkages from the aspect of the propagation of stress waves (in Russian), *Trudī Kuibyshevsk. Inzh.-Stroit. In-ta* no. 4, 125–143, 1957; *Ref. Zh. Mekh.* no. 2, 1958, Rev. 2098.

The problems are examined of the propagation of longitudinal and axial deformations along a bar, neglecting the forces of inertia and internal friction. Obviously, all results obtained in this manner for flexural waves are incorrect.

V. L. Biderman

Courtesy Referativzyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6036. Davids, N., and Kumar, S., A contour method for one-dimensional pulse propagation in elastic-plastic materials, Proc. Third U. S. Nat. Congr. Appl. Mech., June 1958; Amer. Soc. Mech. Engrs., 1958, 503–512.

This paper presents a method for solving graphically certain one-dimensional wave or pulse-propagation problems of elastic-plastic waves. It makes use of contours of stress-strain and particle velocity superimposed on a space-versus-time diagram. A set of basic rules is stated that govern the relationships among the contours, with examples. Using a two-straight-line stress-strain relation, the solution of the problem of propagation of the trapezoidal pulse with peak pressure of somewhat more than twice the yield stress has been presented. The behavior of these contours in the permanently strained region, when interaction of waves by overtaking from the same side occurs, is one of the cases discussed in detail.

From authors' summary by K. Kasahara, Japan

6037. Sneddon, I. N., The propagation of thermal stresses in thin metallic rods, *Proc. Roy. Soc. Edinburgh* (*A*) **65,** 2, 121–142 (Pap. 9), Feb. 1959.

Paper considers elastic rod with lateral surface impervious to heat, subjected to mechanical or thermal end disturbance. Author reviews one-dimensional equations, including coupling effect of volume changes on temperature, and derives exact and approximate expressions for phase velocity and attenuation constant, giving numerical values for aluminum, copper, iron, and lead over a wide frequency range.

Boundary-value problems discussed include the semi-infinite rod with sinusoidal end excitation and more general excitation treated by Laplace transforms with an example of a single square pulse of end stress. A perturbation-method approximate solution agrees well over a wide frequency range with exact solution of the one-dimensional equations for sinusoidal excitation. Finite rod solution is also discussed.

L. E. Malvern, USA

6038. Lessen, M., On the propagation of longitudinal thermoelastic waves through the normal interface between dissimilar solids (in English), 9th Congrès. Intern. Mécan. Appl., Univ. Bruxelles, 1957; **7,** 154–158.

In his analysis the author reviews the thermoelastic equations based on thermodynamic considerations. There are a few misprints in Eqs. [12] and [13] where U_k, U_i should be replaced by u_k and u_i and T_{kk} by $T_{,kk}$. The analysis is applied to solve the title problem and author has indicated how complete solution is obtained by satisfying conditions of continuity of temperature, displacement, normal stress and of heat flux conservation at the interface.

D. N. Mitra, India

Soil Mechanics: Fundamental

(See also Revs. 5920, 5963)

6039. Jones, R., In-situ measurement of the dynamic properties of soil by vibration methods, *Géotechnique, Lond.* **8,** 1, 1–21, Mar. 1958.

Application of vibration methods to determine in-situ soil properties is described in two parts of the paper. Part I describes determination of soil properties from measurements of phase velocity of surface vibrations within the frequency range of 35 to 400 c/s. Using known theory, average values of dynamic shear modulus can be obtained over distances of 50 feet. Part II describes methods for obtaining local values for dynamic shear modulus from resonant frequency of a mass vibrating perpendicular to the soil surface.

Both methods are based on existing theory and show good correlation for the soil types tested. Use of the methods also facilitates location of depth at which there is a sharp transition in elastic properties and the increase in C.B.R. values due to compaction.

J. P. Romualdi, USA

6040. Il'ichev, L. I., Simplified method for the determination of pressure of the soil on the supporting wall (in Russian), Sb. Stud. Nauch. Rabot. Saratovsk. Avtomob.-dor. In-ta no. 3, 55–59, 1957; *Ref. Zh. Mekh.* no. 3, 1958, Rev. 3281.

The pressure of a friable medium on an inclined wall, determined by Coulomb's method, is compared with the pressure on an imaginary vertical wall, to which is added the weight of the wedge (of earth) enclosed between the actual wall and the given vertical wall. It is shown that for a horizontal soil surface, the error arising from the approximate calculation of the soil pressure, as well as the stability coefficients, is of the order of 7%.

N. I. Bezukhov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6041. Babkov, V. P., Methods of determining the design values for the deformation of soils (in Russian), Determination of the deformation modulus of soils, Moscow, Avtotransizdat, 1955, 5–16; *Ref. Zh. Mekh.* no. 2, 1958, Rev. 2201.

Considerations are presented on the methods of determining the modulus of deformation of soils in the foundations of road blankets and airstrip coverings.

From author's summary

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6042. Norman, L. E. J., The one-point method of determining the value of the liquid limit of a soil (in English), *Géotechnique, Lond.* **9**, 1, 1–8, Mar. 1959.

Paper describes an analysis made of the data obtained during the determination of the liquid limit of 455 British soils and 49 soils from overseas made with the object of examining the reliability of the one-point method of determining the liquid limits of soils.

It was found that the one-point method was as accurate as the standard method for the soils examined and that the accuracy obtained was usually of the same order as that determined by other workers in the United States of America and Canada. It was found that with soils with liquid limits exceeding 120% the order of accuracy was not sufficiently good to justify the use of the one-point method with such soils. From author's summary

6043. Hart, E. G., Kondner, R. L., and Boyer, W. C., Analysis for partially penetrating sand drains, *Proc. Amer. Soc. Civ. Engrs.* **84,** SM 4 (*J. Soil Mech. Div.*), Part I, Pap. 1812, 15 pp., Oct. 1958.

Authors present a method for the numerical solution of the differential equation describing the hydrostatic pore pressure in a sand drain. Cylindrical symmetry is assumed and the differential equation approximated by a predictive finite difference equation. Solutions were obtained at successive time intervals by relaxation. Numerical and analytic solutions for a completely penetrating drain were in agreement to within 2%. The proposed procedure was then used to investigate the problem of partially penetrating drains. Calculated consolidations were in close agreement with those observed experimentally. G. C. Wallick, USA

6044. Roinishvili, N. M., Initial data and methods of determination of the basic dimensions of protective installations to counter landslides (in Russian), *Trudi Tbilis. In-ta Inzh. Zh.-d. Transp.* no. 28, 35–104, 1955; *Ref. Zh. Mekh.* no. 3, 1958, Rev. 3283.

Results are made known of observations on the fall of stones on seventeen sections of a railway line, the sections differing by reason of various types of profile, the steepness of the slopes of the embankment, the height from which the stones are dislodged, the nature of the surface covering, the geological structure and the rock formations. The displacement of the stones was due to rock-cutting work. The motion of a stone, within the limits of its bounce, is expressed as the equation of the trajectory of the motion of a body, thrown at some angle to the surface of the slope with an initial velocity of v_0; the velocity vector forms an angle β with the vertical. The magnitude of β is determined by the indirect method of the maximum length of bounce of the stone l_{max}.

The analysis of the material collected in field observations was carried out statistically by drawing graphs of the relative frequency of the values of the velocities of motion in relation to the height of fall H and by the determination of the parameters of the curves for the distribution of probabilities; some curves are given for the safety of the values for the velocity of the stones' motion. The calculated end-velocity v_k of the stones' motion was determined by the formulas

$$v_k = \mu\sqrt{2gH} \qquad (\mu = \sqrt{1 - k\ \mathrm{ctg}\ \alpha}) \qquad [1]$$

where α is the angle of steepness of the slope and k the coefficient characterizing the resistance to the motion of the stones on the slope; curves are given for the calculated velocities and values of coefficients k and μ; these can be applied with values for v_k ranging between 40–45 m/sec. Depending on the steepness of the slopes, three zones can be defined: retarded motion on slopes of less than 28°, where the motion starts at some initial velocity which gradually decreases to zero; accelerated motion on steep slopes (from 28 to 60°), where the motion starts by rolling and changes over to a bouncing motion; free motion on very steep slopes (higher than 60°). When there is woody-bushy growth on the slope the coefficient $\eta < 1$ is introduced into formula [1]. Expressions are put forward for v_k to cover the case of nonuniform slopes. A formula is selected for the angle

$$\beta = [200 + 2\alpha\ (1 - \alpha°/45°)]\ v_k^{-1/3}$$

Knowledge of the value of β enables one to apply known formulas for the elements of the trajectory of the bounce and to determine the clearance dimensions of the protective installations [G. M. Shakhunyants, "The earth bed of railway tracks," Transzheldorizdat, 1953]. Results are given of the observations on the maximum height of bounce above the top of the rail h_{max} and the coefficients of restitution are calculated by the formula

$$\rho = \sqrt{\frac{h_{max}}{H + (v_k^2/2g)\cos^2\beta}}$$

The calculation of clearance dimensions for the anti-landslide installations for lateral protection of the rail track consists of the computations for the (stones') flight and bouncing off; they are based on setting up a calculation trajectory of the most unfavorable bounce of the stone near the trapping installation. Data are produced for the calculation of the stability and durability of anti-landslide devices and an approximate method is given for the dynamic calculation for impact on anti-landslide installations furnished with buffering earthen heaps. A recommended procedure for the calculations for such installations is indicated.

G. I. Ter-Stepanyan
Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6045. Kucherov, P. S., Criteria for the viscosity of rocks (in Russian), *Dop. Akad. Nauk URSR* no. 4, 348–349, 1957; *Ref. Zh. Mekh.* no. 5, 1958, Rev. 5873.

As criteria of the viscosity of rocks the modulus of viscosity and the coefficient of elastic incompleteness are introduced; these are determined from the differential equation for the stressed condition of the elastic-viscous medium.

From author's summary
Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

Soil Mechanics: Applied

(See Rev. 6120)

Processing of Metals and Other Materials

(See also Revs. 5928, 6055, 6077, 6300)

6046. Arnold, R. R., and Whitton, P. W., Stress and deformation studies for sandwich rolling hard metals, Instn. Mech. Engrs., Prepr., 13 pp., 1959.

The cold-working of high-strength metals and alloys into sheet and strip form at the thinner gauges allows the metal manufacturer two alternatives: (1) high capital expenditure on a specialized mill of the Sendzimir or planetary type or (2) where demand does not justify the capital outlay, the application of new techniques utilizing existing equipment. In the latter class, the method of sandwich rolling is examined by theory and by experiment and it is shown that reductions in load up to 60 per cent can be achieved for rolling thin hard strip. The method allows greater reductions than for rolling the metal alone, and decrease in finished thickness is obtained.

A method of adapting current cold-rolling theory for the calculation of loads involved in planning production schedules is set out, based upon a criterion of simultaneous yielding in the hard and soft metal layers. Optimum conditions of metal-thickness ratio and hardness ratio for the sandwich metals are discussed.

From authors' summary

6047. Grigorov, K. V., and Blokhin, G. P., The texture of the deformation when cold rolling a steel of low carbon content (in Russian), *Fiz. Metallov. i Metallovedenie* **4**, 1, 161–170, 1957; *Ref. Zh. Mekh.* no. 4, 1958, Rev. 4840.

Experimental data obtained by the magnetometric method are given regarding the regularity of the development of grain when cold rolling a steel of low carbon content in relation to the degree of deformation, covering a wide range of changes in the latter. An attempt is made to explain the nature of the mechanism obtained, based on the idea of the geometry of the mechanism of the plastic deformation of crystals by means of slip.

From authors' summary

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6048. Korolev, A. A., Change of the limit of plastic flow of a metal along the arc of the grip on a roller when milling (in Russian), Rolling Mills (8), Moscow, Mashgiz, 1956, 217–224; *Ref. Zh. Mekh.* no. 3, 1958, Rev. 3254.

In the first part of the paper, author re-affirms the fact, already known, regarding the increase of the limit of yield from the entry to the exit of the strip from below the rollers, in consequence of the appearance of cold hardening. In the second part, he asserts that in hot rolling the limit of yield along the arc of the clamp falls in consequence of the reduced velocity of deformation between the points of insertion and ejection of the strip from below the rollers. In the view of the abstractor, this assertion is incorrect, if only because of the circumstance that the velocity of deformation decreases along the arc of the clamping to the point of release of the strip and in cold rolling, in that time when the limit of yield is increasing.

K. N. Shevchenko

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6049. Iroshnikov, A. N., Pobedin, I. S., and Khrapov, M. M., Distribution of the specific pressures when rolling fashioned shapes (in Russian), Rolling Mills (8), Moscow, Mashgiz, 1956, 87–106; *Ref. Zh. Mekh.* no. 3, 1958, Rev. 3255.

In rolling fashioned shapes, in the specific case of deep-flanged beams, the metal's plastic deformation takes place under very complex conditions, which makes the mathematical statement of the problem difficult, even with the adoption of extensive simplifications. The authors have set themselves the objective to obtain, at least, an approximate solution by dividing the problem, investigating separately the wall and the flange (of the beam). In order to satisfy the boundary conditions at the ends of the deforming zone, authors introduce boundary supporting and tensioning forces. In doing this the interaction between the flanges and the wall of the beam is disregarded.

K. N. Shevchenko

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6050. Lavrov, P. P., Determination of some parameter during cold milling using smooth rollers (in Russian), Rolling Mills (8), Moscow, Mashgiz, 1955, 201–216; *Ref. Zh. Mekh.* no. 4, 1958, Rev. 4566.

An analysis is given of the experimental curves for the specific pressures during rolling, obtained by A. A. Koroley ["Some investigations of metal deformations during milling," Mashgiz, 1953]; the following assumptions were accepted: the plane of the curvolinear diagram is replaced by an equally sized plane of a rectangle or triangle; P_{max}, corresponding to the apex of the triangle is determined from the Ziebel-Tselikov formulas to meet the case of deformation of a metal between smooth plates; the thickness of strip being rolled is taken to be equal to the mean arithmetical thickness $h_{mean} = \frac{1}{2}(h_0 + h_1)$. A formula is adduced for the mean specific pressure p_{mean} in function p_{max}, into which numerical coefficients are introduced, obtained as the result of the curve analysis worked out by Korolev. A nomogram is given for the graphical determination of the length of contact l_m of the metal with the rollers, taking into account the elastic flattening out of the rollers. A solution, undertaken at the same time, of the equations for p_{mean} and l_m opens up the possibility of giving an opinion on "the limit of the milling capacity of the strip by thickness"; however, the assumptions adopted in making the deductions detract from the value and practical significance of the results obtained.

From author's summary

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6051. Ziegler, M. A., How to design aluminum impact extrusions, *Mach. Design* **31**, 6, 204–210, Mar. 1959.

The impact process is a method for fabricating parts in aluminum by combining, in effect, the extrusion and forging process in a single operation. Physical characteristics of impact parts are similar to those of extruded and forged products.

From author's summary

6052. Schmitt-Thomas, K. G., Borchers, H., and Seul, V., Influence of carbon content, cold working and heat-treatment on the properties of deep drawing steel strip killed by aluminum (in German), *Stahl u. Eisen* **78**, 25, 1798–1808, Dec. 1958.

Authors present the problem and describe the testing equipment and execution of the tests. Test results show effect of annealing after cold rolling on the mechanical properties of the strip; effect of the preliminary treatment on the behavior of the strip during temper rolling and its mechanical properties; influence of the coiling temperature. Interpretation of the test results is made by applying the dislocation theory.

From authors' summary

6053. Averkiyev, Yu. A., Analysis of the squeezing of hollow cylindrical blanks by a tapered die (in Russian), Machines and the technical working of metals by pressure, Mashgiz, 1955, 21–37; *Ref. Zh. Mekh.* no. 2, 1958, Rev. 2150.

Empirical formulas are set up for determining the maximum squeezing force on hollow, cylindrical blanks in a tapered die. The phenomenon of transverse folding is examined. Optimum values are stated for the taper angle at which the applied force is a minimum.

E. A. Popov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6054. Efimov, I. A., Deformation in transverse forging (in Russian), *Trudi Leningr. Politekhn. In-ta* no. 185, 92–101, 1956; *Ref. Zh. Mekh.* no. 5, 1958, Rev. 5815.

It was established that the deformation in transverse forging spreads from the periphery to the center of the forged piece. With a small degree of squeezing with an impact $\delta_1 = 1$ to 3% and with a small angle of turn between the impacts $n_1 = 25 \div 100$ the peripheral layers of the forging get markedly longer at the face. With $\delta > 3\%$ and with a small coefficient of toughening of the material of the forging, the axial part of the face is deformed more intensively. If the coefficient of toughening is of significant size (A1) the periphery of the sample is plastically deformed. Disruption on the axis sets in earlier than the penetration to that spot of the intensive plastic deformation. The irregularity of deformation along the section can be diminished by changing the number of im-

pacts per turn n_1. The most uniform forging is obtained when $5 < n_1 < 10$.

From author's summary

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6055. Teplitskii, E. I., Influence of the shape of the contact surface on the magnitude of settlement in loading tests (in Russian), *Sb. Trudĭ Kafedr. Vyssh. Matem. i Teor. Mekhan. Mosk. Inzh.-stroit. In-ta* no. 1, 72–84, 1957; *Ref. Zh. Mekh.* no. 4, 1958, Rev. 4594.

An investigation is made regarding the influence of the shape of the contact surface of a centrally loaded rigid drop forging press, located on the surface of a soil foundation regarded as an elastic semi-space, on the extent of settlement. Friction on the sole is disregarded. As a plane problem is being investigated where the settlement is equal to infinity, the settlement itself is not determined, but the difference between the settlement of the press on the sole not in plane and on the sole in plane. On the basis of I. Ya. Shtaerman's formulas ["Contact problem in the theory of elasticity," Gostekhizdat, 1949] a formula is derived for this difference for the case of a press with edges rounded in accordance with the parabolic principle. In doing this it is shown that the settlement of such a press is greater than for the plane. On the other hand, the bent-in press will have a smaller settlement according to the theory of elasticity. However, with such a shape near the edges plastic deformations would develop in the soil foundation, increasing the settlement. Hence the deduction is made that the least settlement will be found in the case of a press basically bent-in, but possessing rounded edges, thus preventing the development of plastic deformations below them. The problem is then solved for the determination of the geometrical parameters of such a press. From the condition that contact must take place along the whole of the sole the requirement evolves that the external load must exceed the determined value $P_{min} > 0$. Another problem is then solved into which a supplementary requirement is introduced to the effect that in the press of the given complex form there should not be plastic deformation in the soil not only under the edges but everywhere. In view of the fact that this problem is not capable of solution by analytical methods the method of successive approximations is recommended. However, this method also proves to be so complicated that the author in demonstrating the calculation sequence introduces supplementary arbitrary assumptions.

M. I. Gobunov-Posadov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6056. Cholyshev, N. A., Cutting of metals with shears with parallel blades (in Russian), *Trudĭ Sibirsk. Metallurg. In-ta* no. 2, 109–148, 1955; *Ref. Zh. Mekh.* no. 5, 1958, Rev. 5820.

This is a semi-empirical theory in which the cutting is investigated as the combined work of the elementary processes of bending deformation, impressing, shear and tension.

G. S. Shapiro

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6057. Neronov, N. P., The mechanics of the ball mill (in Russian), *Zap. Leningrad Gorn. In-ta* **33,** 3, 37–53, 1956; *Ref. Zh. Mekh.* no. 2, 1958, Rev. 1544.

An analysis is given of existing theories of the working process and power consumption of ball mills, and a more developed theory is given. The defect of all existing theories is that they fail to consider many details of the motion of the drum-balls-ore system. The general assumption is that comminution of the ore takes place in the inner rows of balls only by normal impact. This is incorrect. Neglect of the residual energy of the balls after completion of their cycle of impact (collision) with the ore leads to reduced values of the theoretical power consumption. The best agreement between theoretical and experimental data is obtained if the forces of interaction between all balls in contact are considered, which, in the first section, after detaching from the drum well, form an arch, follow a catenary line, and collapse at the beginning of the period of free, parabolic motion. The conclusion is reached that it is necessary to develop a theory making allowance for the radial pressure, on the basis of the theory of granular substances, allowing for slip.

V. N. Geminov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

Fracture (Including Fatigue)

(See Revs. 6074, 6078, 6082, 6088, 6403)

Experimental Stress Analysis

Book—6058. Rozanov, N. S., The stereometric method of investigating stresses in plates (in Russian), Moscow-Leningrad, Gosenergoizdat, 1954, 84 pp. + illus.; *Ref. Zh. Mekh.* no. 5, 1958, Rev. 5746.

The present contribution is in much greater detail than in the earlier paper by the same author [*Gidrotekhn. Str-vo*, no. 9, 33–38, 1953] and this is reflected in the exposition of the stereometric method in its application to the investigation of deformations and stresses in thin elastic plates of arbitrary outline with different conditions operating in regard to the fastening of the edges.

A. I. Oseled'ko

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6059. Muller, R. K., A simple procedure for the determination of the major stress trajectories in the case of the plain model experiment using optical stress analysis (in German), *Beton u. Stahlbeton.* **53,** 12, 307–309, Dec. 1958.

Paper deals with determination of stress trajectories in photoelastic models. Author develops a method which reduces time and work; it consists of photographing the isoclinics in pairs in the usual manner. A grid is then placed on each photo oriented in the direction of the principal stresses indicated by that particular pair of isoclinics. The individual photographs are then superimposed and rephotographed. The resulting photograph provides for rapid and easy construction of the stress trajectories.

From author's summary by E. D. Fliess, Argentina

6060. Stankus, A., Application of the optical method for the calculations of beams on an elastic foundation (in Russian), *Trudĭ Kaunassk. Politekhn. In-ta* **6,** 49–59, 1957; *Ref. Zh. Mekh.* no. 5, 1958, Rev. 5914.

A description is given of the investigation of the stressed condition of beams, lying on an elastic foundation and loaded with vertical concentrated forces, by means of the photoelastic method. Models of the beams were made from Bakelite and sheet-rubber was used for the elastic foundation. Results of the investigations of beams of constant and variable heights are furnished.

S. P. Shikhobalov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6061. How to select a strain gage, *Strain Gage Readings* **2,** 1, 3–23, Apr./May 1959. (Stein Engineering Services, 5602 East Monte Rosa, Phoenix, Arizona)

6062. Mulcahy, F. E., Matching strain gages for low temperature operation, *Strain Gage Readings* **2,** 1, 37–38, Apr./May 1959. (Stein Engng. Services, 5602 East Monte Rosa, Phoenix, Arizona)

6063. Broglio, L., The balance method applied to swept-wing stress analysis, *J. Aero. Sci.* **24**, 5, 363–370, May 1957.

6064. Burdukskii, V. V., Distribution of stresses in a ring-shaped test sample during the relaxation process (in Russian), Strength of metals, Moscow, Akad. Nauk SSSR, 1956, 36–40; *Ref. Zh. Mekh.* no. 4, 1958, Rev. 4876.

Results are given of the experimental verification of the assumption that the stresses in the ring during the relaxation process drop proportionally to the initial stress. A straightforward experiment was made for the verification of this assumption to establish the values of the stresses in the ring-shaped samples during the relaxation process, but only in regard to the edge grains, of the sample. Wire strain gages were adopted for the measurements; these were made from constantan wire 30μ in diameter, previously tempered in a vacuum. Each wire strain gage, with a resistance of $\sim$ 120 ohm, had a 10-mm base. On the basis of the experiments made, the following deductions were advanced. The fall of stress calculated in the usual manner when testing the relaxation of the ring of equal deflection resistance agrees with sufficient exactness with the fall of stress measured directly along the contours of the ring by means of the wire strain gages. The difference between the stresses on the inner and outer contours of the ring decreases in the relaxation process. A measure of redistribution of stresses along the contours after equalization does not appear to be dangerous. The stresses on the extreme edges of the fibers in the relaxation process diminish proportionally to the initial stress.

Yu. G. Maksimov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

Material Test Techniques

6065. McSkimin, H. J., Measurement of ultrasonic wave velocities and elastic moduli for small solid specimens at high temperatures, *J. Acoust. Soc. Amer.* **31**, 3, 287–295, Mar. 1959.

An improved buffer rod-specimen unit is described for measuring longitudinal wave velocities in solids at temperatures up to 350 C. The method is particularly useful in determining elastic moduli of single crystals since very small path lengths in any prescribed direction can be employed. The use of molten metals to provide coupling at still higher temperatures is discussed.

Two methods involving mode conversion at an impedance discontinuity are described for measuring shear wave velocities. Application to crystals of cubic symmetry is detailed, with a note on possible extension to less symmetrical crystals of any orientation.

Data for fused silica and single-crystal germanium are listed for temperatures up to 300 C in illustration of the methods described.

From author's summary by M. Greenspan, USA

6066. Mousley, R. F., Clifton, F., and Le Brocq, D., Comparative strength tests of tension bolts with UNF and BSF threads *Aero. Res. Counc. Lond. Curr. Pap.* 416, (Revised version of technical note no. Structures 212), 13 pp., 1959.

Results are given of comparative tests in tension of bolts with Unified Fine (UNF) and British Standard Fine (BSF) threads. Separate tests were made with ordinary nuts, with thin nuts, and with a pair of locknuts. The tests were made early in 1956. The UNF bolts were found on the average to be as strong in tension as the BSF bolts, or slightly stronger.

In general, with a single nut, failure occurred in the thread of the UNF bolts but in the core of the BSF bolts.

From authors' summary

6067. Shelestenko, L. N., Strength of compressed elements made of steel NL2 (in Russian), *Trudi Vses. N.-i. In-ta Zh.-d. Str-va i Proektirovaniya* no. 16, 86–123, 1955; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 13411.

A detailed description is given of the scrupulously carried out tests in the nonelastic region of large models (½ scale) made with low alloy steel NL2 (otherwise SKh L-2), used in bridge construction. A check of the mechanical properties by means of a crusher and tension of normal samples showed that the limits of proportionality, flow and relative elongation lie within the requirements of the GOST standard. The compression of the H-shaped models was carried out on a 500-m press using special devices, assuring good centering and hinge support. The critical load P_* was determined with the aid of load-deflection curve in the condition of deflection increase without load increase. For models requiring a $P_* > 500$m, an eccentric loading was applied with a calculation for P_* according to Sawtell [see S. P. Timoshenko, "Strength of elastic systems," 1955, p. 191]. The tests showed that the critical stress for flexibilities of 40 ÷ 100 is no smaller than that provided for in the standard specification (TUPM-47). The appearance of torsion loss is not studied.

I. K. Snitko

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6068. Barnes, D. F., Preliminary measurements of the strength of melting lake ice, *Trans. Engng. Inst., Canada,* **2**, 3, 108–111, Sept. 1958.

The strength of the ice sheet covering permanently frozen Angiussaq Lake in Greenland was studied during the summer of 1957. The ice temperature remained at the melting point for more than two months during which the thickness decreased from 12 to 6 feet. In-place, cantilever beams cut in the ice gave breaking strengths of 20–30 psi or 1.5–2.0 kg/cm^2, but vertical slits cut in these beams showed that approximately the upper 20 inches of the ice sheet had essentially no strength. Accordingly, the lower part had a strength fairly close to that of cold ice, but the development of tubules in this lower ice reduces the effective beam cross section by about a quarter. The ability of the sheet to support loads of as much as 100,000 lb is confirmed by the presence of rock piles which have rested on the ice for at least five years.

From author's summary

6069. Butkovich, T. R., Recommended standards for small-scale ice strength tests, *Trans. Engng. Inst., Canada* **2**, 3, 112–115, Sept. 1958.

The effects of specimen size and shape on the strength values obtained with small-scale unconfined compressive tests are shown. Results are given that show that a loading rate of 0.5 kg/cm^2-sec is required for all small-scale strength tests to minimize plastic effects which accompany slow loading of ice. The ring test, which is a useful new type of test to measure the tensile strength of ice, is described. Standards for specimen size, shape, and configuration along with loading rates and equipment are discussed and recommended.

From author's summary

6070. Anderson, D. L., Preliminary results and review of sea ice elasticity and related studies, *Trans. Engng. Inst., Canada* **2**, 3, 116–122, Sept. 1958.

There are many methods of determining elasticity that can be used on ice. These can be divided into laboratory and field studies, and further divided into static and dynamic determinations. Two valuable in-place field methods are deflection and seismic. Preliminary results from a mass of data indicate that the elasticity of sea ice is less than fresh ice and varies over at least an order of magnitude. Results obtained from the seismic method are generally at least an order of magnitude greater than small sample static values. Preliminary analysis indicates that elasticity can be related to a parameter which includes temperature, liquid- and air-content.

From author's summary

6071. Ryabinin, Yu. N., Some tests on the dynamic compression of substances (in Russian), *Zh. Tekh. Fiz.* no. 12, 2661–2666, 1956; *Ref. Zh. Mekh.* no. 4, 1958, Rev. 4925.

A method is described by means of which it was possible to obtain the compression of substances at hundreds of thousand atmospheres of pressure. The substance investigated was enclosed in an ampule of 3-mm inside diameter, with a length of 10 ÷ 20 mm. The ampule was placed in a vessel, with an outside diameter of 30 mm, made of duralumin or steel and surrounded by an explosive substance. Investigations were carried out on: NaCl, C, $Pb[NO_3]_2$, $CuSO_4$, $MgCO_3$, S, paraffin, naphthalene and wood. It was shown that after the passage of the explosive wave irreversible changes took place in some of the substances. Thus, in $MgCO_3$ and S there was a change of structure; in NaCl, dissociation; in lead sulphate, resolution; in hydrocarbons, in the author's view, rupture of the hydrogen bond. A compression was attained for graphite at 2000 K up to 470,000 atm, that is, conditions at which a diamond is stable. However, the synthesis of a diamond did not succeed because of, in the author's opinion, an insufficiency of time for the essential reconstruction of the crystal lattice.

V. M. Kardonskii

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6072. Gevondyan, T. A., and Pavlov, E. M., A dynamic method for determining the temperature relationship of the elastic modulus in thin materials (in Russian), *Zavod. Lab.* **22**, 12, 1490–1491, 1956; *Ref. Zh. Mekh.* no. 2, 1958, Rev. 2437.

A description of the apparatus and principle of action of a method and an experimental arrangement for the determination by dynamic means of the temperature coefficient of the modulus of elasticity, for thin materials. The error in the determination of the temperature coefficient of the modulus of elasticity by the method of torsional vibrations does not exceed 1%.

Yu. G. Maksimov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6073. Kubassov, V. A., Improvements in a machine for hot cyclic tests on metals in the condition of alternating plastic deformation (in Russian), *Zavod. Lab.* **23**, 1, 101–102, 1957; *Ref. Zh. Mekh.* no. 2, 1958, Rev. 2449.

The description is given of the heating arrangements in a machine for testing metals at elevated temperatures (up to 450°). As a consequence, modifications were made to the heating apparatus of this machine in which the heating agent is now pure, quartz sand.

Yu. G. Maksimov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6074. Salokangas, J., Method for the determination of mechanical hysteresis loops of steel in the case of large dynamic tensile and compressive loads (in German), State Inst. Tech. Res., Finland, Publ. no. 32, 68 pp., 1956.

The construction of a tension and compression fatigue machine based on resonance principle is described, together with possible sources of error. Force indicator of machine is calibrated by means of electric strain gages to within 1% accuracy. Theoretically predicted behavior of machine is confirmed by test measurements. In operation, oscillatory forms of force and deformation are indicated by means of coils oscillating in magnetic field. Signals introduced into cathode ray oscilloscope produce hysteresis loops, which can be observed continuously from beginning of test to rupture. Variations in hysteresis loops for different steels under uniform stress as function of frequency of stress reversal have been studied. Actual temperature of specimen is measured during test. An attempt is made to explain shape of the hysteresis loop as a function of stress reversal frequency by means of dislocation theory.

W. D. Jordan, USA

Book—6075. Reicherter, G., Handbook of hardness testing according to Brinell, Rockwell, Vickers, 2nd ed. [Handbuch der Harteprufungen nach Brinell, Rockwell, Vickers, 2nd Auflage], Berlin, Springer-Verlag, 1959, 136 pp. + 70 tables. DM 12.50.

Book was compiled by a manufacturer of testing machines (Reicherter in Esslingen, Germany) and contains, in addition to the definitions of the three hardness testing methods mentioned in the title, a description of the machines placed on the market by this firm and a series of examples from which the workshop engineer may learn which of the three methods to apply in different practical cases. The definitions are based on the German industry standards (D.I.N.). The machines are named Briviskop (8 types), Brivisor (10 types), Briro (10 types) and are represented by clear photographs and line drawings. The book is in German, but a number of tables are in four languages (German, English, French and Italian). These tables give minimum sample thicknesses, hardness values as a function of indentation measurements, and conversion tables for the three types of hardnesses and tensile strength.

C. Zwikker, Holland

Properties of Engineering Materials

(See also Revs. 5947, 6047, 6051, 6052, 6067, 6308, 6402)

Book—6076. Hausner, H. H., Modern materials (Vol. I), New York, Academic Press, Inc., 1958, xi + 402 pp. $12.50.

Book is a collection of eight chapters on unrelated materials. Topics covered by specialists in the individual fields are: (1) Some new developments in wood as a material, (2) Synthetic rubbers for special service conditions, (3) Fiber materials, (4) High voltage insulation papers, (5) Special glasses for nuclear engineering conditions, (6) Characteristic properties of modern ceramics, (7) Germanium and silicon, (8) Zirconium.

The book is intended for the non-specialist with broad interests, and it is claimed that the engineer with the usual college background will easily follow thoughts of the authors. In reviewer's opinion there are a number of places in which the treatment falls short of this ideal. For example, the first 17 pages of the book treat the botany and crystallography of wood in a detailed form which reviewer feels will be well beyond the grasp of the book's intended public. As a second example, in Chapter 2, author assumes that the reader has some knowledge of the fundamentals of polymer chemistry. Indeed it appears unlikely that such an extensive field could be summarized in seventy pages without making this assumption. Since the articles are suitable for those with some familiarity of the specific fields, the diversity of topics covered in this one volume is unfortunate. This book is apparently the first of a series, and it is to be hoped that future volumes will treat a more closely related set of materials.

Despite reviewer's criticism of the makeup of the book as a whole, he finds the individual chapters to be well written and authoritative. In Chapter 1 after discussing the nature of wood (see earlier comment), the author gives a very thorough section on physical properties which emphasizes a review of the research rather than engineering data. The chapter is well documented with 111 references. Chapter 2 is written in a very readable style although, as already mentioned, its understanding requires some knowledge of polymer chemistry. The emphasis is on production techniques and resistance to chemical attack, with engineering data being rather limited. 137 references.

Chapter 3 appealed to reviewer as being well suited to the ideal of the book. Author states his purpose as "to judge the extent of advances in the field and on this basis to suggest the direction of research, and of developments in fibers to be expected in the future." The author does not linger unduly on the chemistry of these materials but goes on to give many facts on their engineering prop-

erties. The chapter contains a number of useful tables and 76 references.

The fourth chapter, High-voltage insulation papers, gives a great deal of practical data which should be useful to an engineer entering this field. By its specific nature it does not form easy reading for one interested in merely a general knowledge of materials. 48 specific references and 30 general sources are quoted.

Special glasses for nuclear engineering applications form the subject of the fifth chapter which is presented in a very readable style. Topics covered are shielding glasses, optical glasses protected from radiation coloring, glasses used in dosimetry, and several miscellaneous nuclear engineering uses. The chapter concludes with a short but very satisfactory survey of the fundamental literature. 42 references.

In Chapter 6, the "Characteristic properties of modern ceramics," there is very complete coverage in readable style. However, references to engineering tests and applications could well have been added. The final section "Electrical properties" is a particularly welcome survey of a topic of great current interest. 13 tables and 26 references.

The seventh chapter, "Germanium and silicon," is mainly concerned with the detailed chemical properties of these elements and, in reviewer's opinion, does not belong in the book. The short introductory section "Electrical properties" and the final section "Devices" are very concise and assume some background in solid-state physics from the reader. 65 references.

The final chapter, Zirconium, is the longest in the book and gives a complete account of the uses, extraction, production, fabrication, and properties of this metal. For one interested in its applications, there is perhaps too much emphasis on the extraction and production of zirconium and too little on the basic metallurgy of the metal and its alloys. 104 references and many figures.

I. Finnie, USA

Book—6077. Degarmo, E. P., Materials and processes in manufacturing, New York, The Macmillan Co., 1957, x + 755 pp. $8.50.

Book is intended primarily as a college-level text for engineering students and has been organized to meet the needs of instruction in both materials and manufacturing processes. Author's many years' experience in manufacturing and teaching is reflected in the comprehensive and yet all-round coverage of the two domains and in the many adequately selected illustrations.

A chapter on the planning of manufacturing operations and a list of selected references for additional study enhance the use of this book for graduate engineers.

C. Zwikker, Holland

6078. Pearson, T. F., Defects in steel: a tentative theory, *J. Iron Steel Inst., Lond.* **191**, 3, 219-232, Mar. 1959.

A statistical survey of the defects occurring in a total of over 1000 casts of basic semi-killed plate steels has been made during three periods over several years. It has been found that if the casts are classified according to the silica contents of their tapping slags, then the average defect values expressed quantitatively when plotted against the silica contents give rise to a characteristic and complex curve which shows a minimum average defect level at 13-14% silica. Graphs for each of the periods examined present the same fundamental shape, the minimum defects level always occurring at the same silica value.

It is concluded that all classified defects, particularly those involving the surface of the steel, have a fundamental common cause. A tentative theory based upon the influence of the silica in the slag on the silicon content of the metal (hitherto neglected in basic steel) is proposed.

It is suggested that the optimum silica content of the slag associated with the minimum defect level is indicative of a "balance" between hydrogen and oxygen in the liquid metal, very similar to that pertaining in liquid copper in the "tough pitch" condition. Over a considerable range of slag compositions, normal additions made to the ladle to produce a desired chemical specification exert little influence on the condition of the metal leaving the furnace.

Mention is made of the possible significance of the theory with respect to rimming steels, and very recent work on this type has revealed that the carbon and manganese losses occurring during active rimming in the mould bear a relationship to the total iron contents of the tapping slags which strikingly resembles in its form that of the defects curve for semi-killed steels. Hydrogen is suggested as a causative factor.

In conclusion the influence of different modes of refining on "bath condition" is considered and emphasis is laid on the importance of the slag as the governing factor in the production of quality steel.

From author's summary

6079. Wheatley, C., and Pope, J. A., An investigation into the creep properties of two cast-irons, *NE Coast Instn. Engrs. Ship. Trans.* **75**, 6, 331-354, Mar./Apr. 1959.

To classify in order of creep resistance the cast-irons used by manufacturers of marine diesel engines, "quick sorting" creep and stress-relaxation testing equipment was developed. The tests conducted on two similar plain irons are given with specific strain and stress-relaxation curves.

From authors' summary

6080. Ross, S. T., Sernka, R. P., and Jominy, W. E., Some relationships between torsional strength and electron microstructure in a high carbon steel, *Trans. Amer. Soc. Metals* **50**, 163-180, 1958.

6081. Pugh, J. W., The tensile and stress-rupture properties of chromium, *Trans. Amer. Soc. Metals* **50**, 1072-1080, 1958.

6082. Parker, E. R., Modern concepts of flow and fracture, *Trans. Amer. Soc. Metals* **50**, 52-104, 1958.

As an introduction, the author underlines the importance of "solid state" science for the progress of high-temperature alloy development. The lack of progress in this field has been due to an inadequate understanding of, and the failure to develop, such knowledge concerning solid-state physics. As an example of this lack of progress, it is mentioned that during the last fifteen years very few new gas turbine alloys have been developed and, as a result thereof, the maximum operating temperature has been raised only 93°C (200°F)—but this was mainly due to better mechanical design and better quality control.

Author then begins the review of "Concepts of flow and fracture" with a description of the dislocation theory and, using this basic theory, he explains several concepts including strain hardening and recovery. The different theories of creep and solution hardening are also considered. Finally, in a brief part about fracture, author mentions some recent work on the origin of "fracture nuclei in fatigue" which is said to be "very illuminating." Some encouraging results which have been obtained with single crystals of magnesium oxide are also mentioned. Surface elongation up to 20% has been obtained in some bend tests. This appears to give a good chance to develop useful ductile ceramic materials.

B. Lofblad, Sweden

6083. Loria, E. A., Evaluating high-temperature materials, *Mach. Design* **31**, 11, 121-125, May 1959.

Correct interpretation of data from tests on materials properties often helps to improve designs. Which test to use, though, is often a problem. Article is a rundown on properties tests and their significance.

From author's summary

6084. Wachtman, J. B., Jr., and Lam, D. G., Jr., Young's modulus of various refractory materials as a function of temperature, *J. Amer. Ceram. Soc.* **42**, 5, 254-260, May 1959.

Young's modulus as a function of temperature was determined by a dynamic method for single-crystal sapphire and ruby and for poly-

crystalline aluminum oxide, magnesium oxide, thorium oxide, mullite, spinel, stabilized zirconium oxide, silicon carbide, and nickel-bonded titanium carbide. For the single crystals, Young's modulus was found to decrease linearly with increasing temperature from 100 C to the highest temperature of measurement. For all the polycrystalline materials, except silicon carbide, stabilized zirconium oxide, and spinel, Young's modulus was found to decrease approximately linearly with increasing temperature until some temperature range characteristic of the material was reached in which Young's modulus decreased very rapidly and in a nonlinear manner with increasing temperature. This rapid decrease at high temperature is attributed to grain-boundary slip. Stabilized zirconium oxide and spinel were found to have the same rapid decrease in Young's modulus at high temperature, but they also had a decidedly nonlinear temperature dependence at low temperature.

From authors' summary

6085. Welterlen, J. D., Aeronautical and space applications for ceramics, *Aero/Space Engng.* **18**, 4, 72–75, Apr.1959.

6086. Panarin, N. Ya., Some questions of calculations for reinforced and un-reinforced concrete with consideration for creep (in Russian), Avtorefer. Diss. Dokt. Tekhn. Nauk, Leningr. Inzh.-Stroit. In-ta, Leningrad, 1957; *Ref. Zh. Mekh.* no. 5, 1958, Rev. 5836.

6087. Benthem, J. P., Note on the compressive and bending strength of fiberglass reinforced plastic plates, *Nat. LuchtLab. Amsterdam TN* S.531, 28 pp. Oct. 1958.

With the aid of a simplified model consisting of many thin layers, alternatively of glass and of plastic, which show a wave form (like warp and weft threads do), author tries to give an explanation for the well-known fact that above a certain glass percentage the compressive strength does not increase with the glass percentage and for the fact that the bending stress at failure increases if thickness decreases. Quantitative predictions, however, could not be given.

From author's summary

6088. von Hippel, A., Principles of modern materials research, Massachusetts Inst. Technol., Lab. for Insulation Res. TR 136, 24 pp., Mar. 1959.

Structures: Simple

(See also Revs. 5914, 5940, 5943, 5949, 5952, 5954, 5975, 6067)

Book—6089. Benjamin, J. R., Statically indeterminate structures—approximate analysis by deflected structures and lateral load analysis, New York, McGraw-Hill Book Co., Inc., 1959, ix + 350 pp. $11.

This book is of great value both as textbook and as guide in engineering practice. It is largely concerned with the approximate analysis of statically indeterminate structures. In Chapter 1, author emphasizes the fact that all structural analyses and designs are approximate, which is true, since many assumptions are made which do not comply with actual conditions. Very often, assumed dimensions, which are so important for statically indeterminate structures, must be changed in accordance with the results of the first analytical procedure, so that the initial approximate analysis saves considerable time.

Chapter 2 reviews structural mechanics, i.e. statical indeterminancy, deformations, preliminary deformation models, elastic and plastic behavior. Chapters 3, 4, 5, and 8 thoroughly discuss analytical procedures under vertical loads, and the effects of lateral loads are covered in Chapters 6 and 7, in which also rigid frame structures and shear-wall structures are studied. Chapter 8 presents approximate analysis of miscellaneous structures, like bents, bents with sloping and inclined members, gabled bents, and arches. Chapters 9 and 10 deal with some aspects of the philosophy of structural engineering, in similar, very interesting ways as recently presented in Torroja's book "Philosophy of structures," emphasizing the relationships between analysis and design, the knowledge of which is of great value in understanding the overall design problem. Of special interest to students and engineers are the described checking methods of the analyses, which in many books in this field are overlooked or only superficially mentioned. Chapters are amply illustrated, explained by numerical examples, and contain problems to be solved by the reader and important references.

Reviewer believes that greater attention should be given to some time-saving analytical methods which provide basic characteristic data of the designed structure to be used for any type or arrangement of the loading—necessary for safe design—so that a great part of the analytical procedure need not be repeated, such as method of "fixed points" and methods based on properties of the "ellipse of elasticity."

J. J. Polivka, USA

Book—6090. Borg, S. F., and Gennaro, J. J., Advanced structural analysis, Princeton, N. J., D. Van Nostrand Co., Inc., 1959, xiii + 368 pp. $7.50.

In addition to the usual subject matter of books on indeterminate structures, chapters on numerical methods of determining deflections, torsion of noncircular sections, limit design, slab and shell structures and electronic computer solutions are included. The more traditional techniques are clearly and completely presented, but reviewer feels that the theoretical justification is often weak and inadequate. This is particularly true of the treatment of the Principle of Virtual Work. The presentation of the newer subject matter is necessarily sketchy. In the chapter on limit design, for instance, the upper and lower bound theorems are not mentioned. The derivations of the equations used for slab and shell structures are, to a large extent, omitted. Reviewer questions value of such simplified and abbreviated consideration of so many important topics.

F. L. Dimaggio, USA

Book—6091. Ashby, R. J., and Chilver, A. H., Problems in engineering structures, New York, St. Martin's Press, 1958, iv + 168 pp. $4.50.

The aim of this short book is to give the students of engineering structures a collection of examples. These are presented in such a way as to make it easier for them to understand the theorems explained at lectures and their practical applications.

The division of topics covers in broad lines that of the excellent book by Pippard and Baker "The analysis of engineering structures," [Arnold, 3rd ed., 1957] and may be considered as a complement to it. The examples given correspond mostly to the material of the first two university years. The problems selected are taken from a great variety of fields of statics. Beginning with the simplest problems, the book leads gradually toward the solution of questions demanding more experience and skill. It presents the solution of some examples with all the details needed for their complete comprehension. At the same time, it contains problems whose solution is left to the reader. In these latter cases, the book only gives the final results.

Although authors selected the examples mostly from the material of introductory studies, they have nevertheless endeavoured to offer insight into the newer domains of statics. It is a pity they did not treat the plastic design of redundant pinjointed frames before dealing with that of beams. This would have rendered possible a better understanding of the new principles.

The booklet offers useful help to university students and, as such, it may be warmly recommended.

P. Csonka, Hungary

Book—6092. Mutermilch, J., Olszewski, E., and Lubinski, M., New methods of designing steel structures [Wyniarowanie Konstrukcji stalawyck; noue metoda], Warzsawa, Budownictwo i Architectura, 1956, 312 pp.

Progress and recent developments in structural analysis are described, and various methods are discussed with emphasis on their advantages and disadvantages. The main subject of the book refers to methods of design in consideration of the fatigue and plasticity of structural analysis. J. J. Polivka, USA

Book—6093. Kuczynski, W., Structural concretes—methods of controlling proportions by iteration [Betony construkcyzne; projektowanie metoda kalejnych przyblizen (iteracji)], Warzsawa, Budownictwo i Architectura, 1956, 220 pp.

Fundamentals and nature of structural concrete, proportioning of mixes, composition of paste, hardening processes, curing, frost resistance, shrinkage and swelling, inspection and testing of cement and aggregates, and other properties and procedures of importance for the best use of this modern building material are thoroughly described, with references to test results in Poland and other countries. J. J. Polivka, USA

6094. Biermann, W., Periodical iteration sequences in the calculation of statically indeterminate rod systems (in German), *Bautechnik* **35**, 11, 432-436, Nov. 1958.

Discussion is given, primarily through the detailed study of some specific, illustrative examples, of the analysis of statically indeterminate rod and framed structures by means of iterative techniques. H. G. Hopkins, England

Book—6095. Neumann, G., Handbook of practical design of structures in reinforced concrete, with practical examples, [Manuale del Calcolo Pratico del Cemento Armato—con esempi sviluppati di applicazioni pratiche] 2nd revised and amplified edition, Roma, Edizioni Cremonese, 1958, xii + 280 pp. L 3200.

Author, one of the leading Italian specialists in reinforced and prestressed concrete, based this handbook on his idea that structural design of concrete structures should be performed with greatest simplicity and reliable accuracy. General assumptions in design are approximate anyway, and therefore it is more important to design concrete structures for greater safety using very simple procedures and methods rather than with complicated calculations involving advanced knowledge of exact theoretical analysis. These simplified methods, complying with existing codes and regulations, are presented and thoroughly illustrated by a great number of practical examples referring to typical concrete structures, and also to modern structural types with all recent developments, such as shells, domes, and other space structures.

Most of the numerical examples of more complicated structures show those designed and supervised by the author, and are illustrated by photographs taken during various stages of construction. A number of tables, charts and diagrams contribute essentially to the simplicity and the accuracy of design. In this respect, Dr. Neumann's handbook can be considered unprecedented and of great value, especially for young engineers and engineers having limited experience in modern concrete design. Special chapter treats the glass-concrete structures, amply used in Europe for shell and dome roofs of large spans covering rooms where daylight illumination is required. Glass-concrete, monolithic material composed of concrete, steel and glass units, all bonded together, also requires consideration of the ratio $m = E_g/E_c$, (moduli of elasticity of glass and concrete), equal in typical cases to $m = 3$. Author gives full credit to engineers of international reputation, such as Emperger, Saliger, Santarella, Belluzzi, Moersch, Hennebique Dischinger, Ros, Rinaldi, Guidi, Considere, Czerny, Kleinlogel, Cross, Rieger, Strassner, Loser, Baroni and others.

J. J. Polivka, USA

6096. Scholz, G., Contribution to theory of steel reinforcement of flat (two-dimensional) concrete structures (in German), *Beton u. Stahlbeton.* **53**, 10, 250–255, Oct. 1958.

Paper is concerned primarily with structures in which directions of reinforcing steel network do not coincide with directions of principal stresses, as when network is parallel to sides, but sides are not at right angles. Equations are derived for stresses on usual assumption that concrete is capable of withstanding compression only, and that all tensile forces are resisted by steel only. By introduction of suitable additional bending moments and forces, expressions can be generalized for use with plates and shells. C. W. Smith, USA

6097. Ulitskii, I. I., The stressed condition of sections of ferroconcrete components, emerging as the result of the shrinkage of the concrete (in Russian), *Novoe v Stroit. Tekhn.* no. 11, 77–99, 1957; *Ref. Zh. Mekh.* no. 5, 1958, Rev. 6021.

A study is made of the creep of the concrete, the increase of the modulus of elastic deformation and also of the duration of the shrinkage. The characteristic of the creep of concrete φ_t is recorded (according to Kelvin) in the form of $\varphi_t = \alpha[1 - \exp(-bt)]$. For modulus E_t and shrinkage α_t the following formulas are proposed

$$E_t = E(1 + \delta\varphi_t), \qquad \alpha_t = \alpha\frac{\varphi_t}{\alpha}$$

where E is the initial modulus, α the limiting relative shrinkage, t the time, α, b and δ constants. Equations of equilibrium are derived for a section of a ferroconcrete beam with one axis of symmetry and double unsymmetrical reinforcement. Arising from the equations of joint action of the deformation of the concrete and reinforcement an integral equation was obtained and a solution given in the form

$$\sigma = \frac{\alpha E}{a}[1 - \exp(-\xi\varphi_t)]$$

where σ is the stress on the concrete at the center of gravity of the reinforcement and ξ is a value depending on the degree of reinforcement. N. I. Malinin

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6098. Nichiporovich, A. A., and Khrustalev, N. Ya., Strength of concrete water-containing installations on soils free from rock (in Russian), Moscow, Gos. Izd-vo Lit. po Str-vu i Arkhitekt., 1957, 190 pp. + illus. 10r 10k; *Ref. Zh. Mekh.* no. 5, 1958, Rev. 5875.

Results are described of investigations carried out in the period 1946–1954 on the stability of installations to shear and on the carrying capacity of their foundations. An analysis is given of the existing methods of calculation employed in the USSR for the stability of foundations, establishing the limiting values for the intensity of the vertical load p_{cr} and of the horizontal load q_{cr} (the methods of V. I. Novotortsev, V. V. Sokolovskii, N. M. Gersevanov, P. P. Laupman and others). Results are discussed of the experiments carried out in the laboratories of VODGEO and of VNIIG; the modelling conditions are examined. The curve, drawn in accordance with the experimental data, of the relation $q = f(p)$ differs from the theoretical curves obtained by the methods of Novotortsev, Gersevanov-Laupman, Sokolovskii and others (fig. 48). The theoretical values of the shearing forces q for the given vertical specific pressure are 2–3 times smaller than the experimental values. Authors, in view of the experimentally obtained relation of $q = f(p)$ propose their own method for the calculations of the stability of foundations on nonrocky soils. A comparative evaluation is furnished for the efficiency of the different constructions of the underground contour of the dam. N. K. Snitko

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6099. Watstein, D., and Mathey, R. G., Strains in beams having diagonal cracks, *J. Amer. Concr. Inst.* **30**, 6, 717–728, Dec. 1958.

The following interesting results have been obtained for the behavior in the region of diagonal cracks: (1) Strain at top fiber decreased and even became a small tensile strain, maximum compressive strain occurred somewhat below top fiber; (2) strain in reinforcing bars near support increased considerably after cracking; (3) before cracking, longitudinal bars carried considerable amount of shear which, however, decreased after cracks had formed.

H. Craemer, Germany

6100. Urcelay, J. M., Optimal design of sections of prestressed concrete (in Spanish), *Inst. Tech. Construct. Cem. Publ. Madrid* no. 193, 1958.

Minimum weight of nonprestressed reinforcement is considered as a criterion for optimal design of prestressed concrete beams. I sections acted on by two distinct values of bending moments and subjected to a given total tensile force on the prestressed reinforcement are studied.

A nonlinear stress-strain relation for concrete (proposed by Torroja) is adopted. Rupture is supposed to occur for a given strain in the concrete and a given yielding stress in steel. Nomograms to simplify the computations are given.

Paper is not clear, but several examples at the end facilitate the understanding. F. Borges, Portugal

6101. Bufler, H., A new approach to the calculation of wire tension and adhesion forces in reinforced concrete (in German), *Bauingenieur* **33**, 10, 382–388, Oct. 1958.

Theoretical equation is derived for the distribution of stress in a concrete cylinder with a centrally embedded prestressing wire. Cylinders subjected to four different loading conditions are considered: (1) tension applied to both ends of the wire; (2) tension applied to both ends of the concrete cylinder; (3) forces caused by deformational changes (release of prestressing, temperature and shrinkage); and (4) tension applied to one end of wire and compression applied to the corresponding end of concrete cylinder.

The equation is based on the compatibility of strains on the surface of the wire. The compatibility equation contains an empirical parameter characterizing the degree of bond. Further assumed is a linear relationship between stress and strain both in the concrete and in the wire.

Solutions of the differential equation are compared with the results of two earlier experimental studies and with empirical formulas found in the literature. Generally good agreement is indicated. I. M. Viest, USA

6102. Bannister, J. L., Characteristics of strand prestressing tendons, *Struct. Engr.* **37**, 3, 79–86, Mar. 1959.

6103. Douglas, A. H., Elastic analysis of two-dimensional indeterminate frames, Parts I and II, *Concrete Constr. Engng.* **54**, 4, 139–150, Apr. 1959; **54**, 5, 175–185, May, 1959.

Various common methods of analyzing elastic frames are briefly compared. After indicating the general solution using matrix method of presentation, author reviews moment-area method, relaxation method and strain-energy method, and illustrates each by examples. G. G. Meyerhof, Canada

6104. Yamamoto, M., and Inoue, H., Stress distribution and its calculation in corner of rigid-frame structures with many panels (in Japanese), *Trans. Japan Soc. Civ. Engrs.* no. 62, 16–24, May 1959.

By the two-dimensional photoelastic experiments of Y- and T-type corners of rigid-frame structure, authors were able to make clear the stress distribution in the sections which are important on the design of the corners. They comment on the approximate calculation which has been hitherto used and propose their improved method.

From authors' summary
Courtesy, Editorial Committee of the Japan Society of Civil Engineers

6105. Barta, T. A., Frames with curved beams, *Concrete Constr. Engng.* **54**, 3, 115–116, Mar. 1959.

6106. Beres, E., Lovass-Nagy, V., and Szabo, J., Stressing of three-dimensional cyclically symmetric frames (in German), *Stahlbau* **27**, 11, 281–284, Nov. 1958.

This work is an application of E. Egervary's method of inversion of hypermatrices consisting of commutable blocks to the solution of redundant structures. The cyclically symmetric three-dimensional frame, solved in the classical manner using matrix analysis, provides for this type of hypermatrices. A numerical example is worked out. J. Solvey, Australia

6107. Hangan, M., The determination of the critical length of columns in frame works using step by step approximations (in German), *Bautechnik* **35**, 8, 303–308, Aug. 1958.

Building frames with and without side-sway are considered. The main assumptions underlying the method are: elastic material; buckling occurs in the plane of the frame; loads are applied at the joints and do not change their directions; frames with side-sway are multistoried.

The method itself is, briefly, as follows. The column under consideration is assumed to be elastically restrained at its ends. Then the characteristic equation is established in terms of the critical parameter and the elastic-restraint factors which can be related to the properties of the rest of the frame. The characteristic equation is a difficult transcendental equation and author recommends successive approximations for its solution.

Two simple examples are presented. The general buckling of a story is also considered. R. Schmidt, USA

6108. Pfister, F., Approximate calculations for the design of reinforced concrete floors without crossbeams (in German), *Schweiz. Bauztg.* **76**, 51, 795–798, Dec. 1958.

6109. Watson, H., Matrix methods for framework analysis, *Aircr. Engng.* **30**, 358, 362–366, Dec. 1958.

Method of minimum strain energy is expressed in matrix form for pin-jointed redundant frameworks. Application is shown for system with 63 members, 9 of which are redundant. Partitioning is required for some matrices due to limitations of Ferranti Pegasus computer. Problem would require several months if done by hand but can be done by two inexperienced operators in about three weeks with only three hours of machine time. Number of redundants has little influence on complexity of problem. Method is recommended for reasonably complex systems or where a large number of loading cases must be considered.

R. B. McCalley, Jr., USA

6110. Fuxa, U., A simple observation on the applicability of the Gehler method to the calculation of multiple frames with staggered floor levels (in Italian), *G. Gen. Civ.* **96**, 10, 633–635, Oct. 1958.

6111. Sorokin, P. I., Some relations of geometrical dimensions of sections of frames made of thin-walled tubes (in Russian), *Prikl. Mekhanika* **3**, 2, 179–185, 1957; *Ref. Zh. Mekh.* no. 5, 1958, Rev. 5885.

An examination is made of the frame of a motor car made of thin-walled tubes of channel section when subjected to torsion by antisymmetrical forces. Author proposes to identify the sections of the tubes meeting at the joints from the condition of parity of

the deflection-torsion stresses at the ends of the tubes. Then the distribution of the material would have the more rational aspect. With two tubes joining at the node, it is proposed to assume their section to be equal. With three tubes meeting in a joint, two of which appear to be extensions of each other, while the third is perpendicular to the first two, author derives an equation linking the geometrical dimensions of the sections, from which a determination is made for the most satisfactory width of the flange of the transverse tube. For the chassis of the automobile "ZIL-150" the magnitude b_1 obtained by the above method was smaller than in the actually constructed chassis. However, it must be noted that the bending stress due to symmetrical loading was not taken into account. A. I. Strel'bitskaya

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6112. Engalychev, S. A., Determination of the deformations of three-dimensional frameworks (in Russian), *Trudi Leningr. Voen.-Mekhan. In-ta* no. 6, 124-140, 1957; *Ref. Zh. Mekh.* no. 5, 1958, Rev. 5930.

The new position is determined of a loaded elastically movable joint, attached to the earth with the aid of a triad of rods, as points of intersection of three spherical surfaces with centers in immovable hinges and radii equally deformed along the length of the rods. Because of the smallness of the deformation of the spherical surfaces these are replaced by elementary surfaces perpendicular to each of the three rods. Formulas are derived for the determination of the coordinate displacements as well as displacements in accordance with the given direction of the angle being investigated. The latter formulas can also be presented in vector form, through the ortho position of directions of the rods in the triad and the given directions, by means of which the displacement is determined, or, as is also possible, through the parallelepiped spaces formed by these ortho positions. The "equation of four displacements" is deduced, which establishes the relation between the given displacements of joints and the displacement of the joint linked with those joints by three rods, caused by the joints' loading, change of temperature and incompatibility between the constructionally designed and actual lengths of the rods. Examples are given of the application of the deduced relations to the calculations for three-dimensional redundant frameworks with one elastically articulated joint and with a star-shaped disposition of the rods (radiating fastening). A. A. Gorin

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6113. Kuzmin, N. L., A simplified method of solving frame-distortion problems (in Russian), Investigations on the theory of structures, no. 7, Moscow, Gosstroiizdat, 1957, 495-510; *Ref. Zh. Mekh.* no. 2, 1958, Rev. 2218.

As indicated in the paper, this is a development of the idea of Wan Huan Yuan (Kharbin Polytechnic Institute, Chinese People's Republic). The particular feature of the proposed simplification consists in that a part of the unknown is already eliminated at the stage when the classical equations are set up. This exclusion of a part of the unknowns costs more time, compared with the classical methods (for the plotting of some auxiliary curves, and for additional calculations). At the end of the paper, an approximate method is described for calculating multistory, multiple-span frames for cases in which the influence of the displacements is insignificant. The loads are divided into groups, applied to adjacent spans. The influence of such loads on the bending moments in more remote frame bars is not great; consequently, only the displacements of adjacent joints are considered. In the final stage, the analysis is performed by summation. A similar technique is used in the solution of infinite, regular systems of equations, using abbreviated methods [L. V. Kantorovich, V. I. Krylov: "Approximate methods of higher analysis," Moscow-Leningrad, Gostekhizdat, 1949, para. 2, p. 30].

L. K. Narets

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6114. Shaikevich, V. D., Elements of the theory of matrix focal relations (in Russian), *Sb. Nauchn. Pra. Dnepropetr. Inzh.-Bud. In-ta* no. 3, 111-130, 1957; *Ref. Zh. Mekh.* no. 5, 1958, Rev. 5881.

Following Sh. M. Gofman [*Trudi TAShIIT* no. 2, 1949], author develops the idea of applying the matrix generalized method of foci to the calculations of multispanned multistoried frames with vertical bracing. It is shown that, applying the method of deformations for the calculations of such frames, the matrix of the coefficients of the corresponding system of canonical equations can always be recorded in the form of a three-mesh matrix. Action above the cage matrices is carried out by the same formal rules as in the case where numerical elements are present instead of the cages. What has been said enables a very wide generalization to be carried out for many methods of calculation: in mathematics, for instance, Gauss' algorithm can be generalized (the solution of a system of linear algebraical equations with the simultaneous exclusion of groups of unknowns); in constructional mechanics, by this method, many specialized ways can be generalized; for example, the method of foci. The last possibility is actually used in the work being reviewed, inasmuch as the principal condition is observed—the matrices for the given frames are three-caged. The corresponding generalizations are described in detail for nearly all the methods (including checking methods) of the generally known method of foci. However, it should be noted that: (1) the calculations of the matrices of the focal relationships entail the handling in a large number of matrix operations of additions of multiplications and conversions, which in the case of frames with many spans means a large bulk of computational work; (2) in the generalized method of foci it is found necessary to apply the load to the frames story by story in a way similar to that employed in the ordinary method of foci of applying the load to the continuous beams span by span. Consequently, in the general case of frame loading it is necessary to ascertain the total curvatures of the bending moments due to joint loads. L. K. Narets

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6115. Angervo, K., and Putkonen, A. I., Extension of the bending theory of columns without tensile strength and its application to the calculation of frame structures with unreinforced columns (in German), State Inst. Tech. Res., Finland, Publication 34, 60 pp., 1957.

Rectangular compression members loaded eccentrically in their plane of symmetry and made of a material possessing no tensile strength are considered. Formulas are derived for the angular displacements at the ends of such members for different magnitudes and signs of load eccentricities. For the parameters corresponding to the most important practical cases the results are presented on graphs. Based on this work, frame structures with compression elements made of a material without tensile strength, such as brick walls, can be treated by means of an iterative method illustrated in the text. E. P. Popov, USA

6116. Lightfoot, E., and Sawko, F., Structural frame analysis by electronic computer, *Engineering* **187**, 4843, 18-20, Jan. 1959.

Authors consider the solution of the grid framework, loaded and supported laterally, by means of the generalized slope-deflection method and with the aid of a computer. The static equilibrium at the various joints yields a set of simultaneous linear equations which, when solved, permit determining the forces and moments acting at the end of each structural member. The basic slope-

deflection equations for the plane framework, loaded and supported in its own plane, are very similar to those of the present problem. Authors utilize this similarity and adapt a plane-framework program, written for the Ferranti Pegasus computer, to obtain results for two examples. Results of one example are compared with experimental recordings on a model.

The permament increase in information on the use of electronic computers in the analysis of problems suggests the working out of a catalog of the master programs available.

Z. Karni, Israel

6117. Herzog, M., Simple mushroom head shape simplifies construction (in German), *Bautechnik* **35**, 12, 474-477, Dec. 1958.

The advantages of mushroom head shape over conventional deck-column steel cap construction is expounded. By replacing the simple mushroom head shape by a statically equivalent circular plate-column combination, author carries out calculations in two examples, showing that lower shearing stresses, etc., are obtained with the statically equivalent column compared to conventional deck-cap design. Reviewer believes that theme of paper is worthy.

A. P. Boresi, USA

6118. Taylor, J. L., Exact results for the bending shear stress distribution for some simple sections, *J. Roy. Aero. Soc.* **63**, 579, 181-182 (Tech. Note), Mar. 1959.

6119. Tajimi, H., Basic theories on a seismic design of structures (in English), *Rep. Inst. Indust. Sci., Tokyo Univ.* **8**, 4, 1-46, Mar. 1959.

Paper is concerned with the dynamic problem involved in the earthquake-resistant design of structures. In the first part a calculation method is presented enabling a rapid prediction of design stress at any point in the structure subjected to earthquake. The method utilizes the statistical method as a basis. It is assumed that earthquake motion can be considered as a stochastic process and to have a simplified form of power spectrum characterized by some constants to be determined on the basis of many observation records. The validity of the proposed method is discussed by comparison with the observed data in actual buildings.

In the last part the damping of structure caused by dissipation of its vibrational energy to the ground is investigated. Theoretical analysis is given for the problem that a foundation supporting a vibrating system rests on a semi-infinite elastic medium. The calculated results are compared with the experimental results of vibration tests of existing buildings and machine foundations. For further comparison, a model test is reported which was carried out under the conditions corresponding to the assumptions used in the theory.

From author's summary

Courtesy, Editorial Committee of the Japan Society of Civil Engineers

6120. Akai, K., Correlation between the degree of consolidation and the strength increase of foundations (in Japanese), *Trans. Japan Soc. Civ. Engrs.* no. 60, 46-53, Jan. 1959.

To determine how strength changes with degree of consolidation of foundations, a series of triaxial compression tests has been performed using Ōsaka alluvial clays. The result obtained indicates that the failure envelope corresponding to an arbitrary degree of consolidation can be drawn between the conventional ones of Q-test and Q_c-test, and that the strength constants which should be applied to the bearing capacity formula of consolidating soft foundations due to the surcharge load can be determined by the above failure envelope.

From author's summary

Courtesy, Editorial Committee of the Japan Society of Civil Engineers

Structures: Composite

(See also Revs. 6014, 6092, 6401)

Book—6121. Hawranek, A., and Steinhardt, O., Theory and design of steel bridges [Theorie und Berechnung Der Stahlbrucken], Berlin, Springer-Verlag, 1958, xii + 426 pp.

Theories and procedures for the design of steel bridges would be a more descriptive translation of the title. The book is, in fact, a very well-organized selection of chapters from the theory of elasticity, strength of materials, and from structural theory. They are presented in a sequence that finds application in the analysis and design of various bridge structures. Chapters I to IV include basic strength of materials, theory of elasticity, the theory of isotropic and orthotropic plates and grids and the theory of elastic stability of simple members, plates and various structural configurations. Mathematical approaches to the solution of typical cases are discussed, actual design procedures and the German specifications are shown and explained. The discussions are short and concise; a familiarity of the reader with the subjects is presumed.

The discussion of the floor systems separates the theoretical chapters from the discussion of various bridge systems. The specific structural systems such as plate and box girders, trusses, arches, suspension structures and composite structures (steel and reinforced-concrete) are discussed in five separate chapters. The discussion of plate girders includes an exhaustive study of the torsional effects and deals in great detail with continuous girders. The effect of secondary stresses and problems of elastic stability receive special attention in the chapter on truss bridges. The interaction of the arches and continuous floor systems, the stability of the arches and their wind-bracing systems are discussed to a considerable extent. The treatment of suspension bridges includes flexural and torsional vibration effects but it does not go beyond Steinman's method of handling this subject and authors apparently are not aware of more recent developments and publications in this country. The concluding chapter on composite structures seems to be a short late addition. The general structure of the book, though, differs from similar treatises in the English literature in abundant theoretical material and a presentation which tries to be rather authoritative. Its limitations are that it only gives methods which seem to be well accepted. However, it can certainly be useful as a reference source.

D. D. Vasarhelyi, USA

6122. Bol'shakov, V. A., Hydraulic calculations for spillway bridges (in Russian), *Trudi Kievsk -Avtomob. -Dor. In-ta*, Sb. 3, 163-167, 1957; *Ref. Zh. Mekh.* no. 4, 1958, Rev. 4125.

Author designates the hydrotechnical structure, consisting of a spillway dam with a bridge situated immediately below it, a spillway bridge. A method is proposed for the hydraulic calculations for such a structure, with the condition that the level of the "lower water" does not influence the flow under the bridge; the problem to be solved in the calculation is seen by the author to be "the determination (of) dimensions of the openings in the bridge and in the dam, if they are not equal to each other, and of the necessary reinforcement of the channel under the bridge, corresponding to the maximum velocity of the flow of the structure." The solution is based on the ordinary formulas in hydraulics with the application of coefficients, which have been rendered more precise by means of experiments carried out with a given profile for the dam and a given mutual disposition of dam and bridge.

V. S. Muromov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6123. Nazarenko, B. P., Calculations for spanned structures of prefabricated ferroconcrete bridges of the beam type, taking into

account the elastic distribution of the load (in Russian), Khar'kov Regional Scientific-technical Conference Relating to Ferroconcrete Structures, Dec. 13–15, 1954; Khar'kov, 1956, 93–101; *Ref. Zh. Mekh.* no. 4, 1958, Rev. 4715.

Results are given for the calculations of a composite beam network under the action of a concentrated symmetrical force, with no account being taken of the torsion of the beams. In the proposed method of calculation for the beam system the distribution of the load into a transverse direction is performed by its transfer onto 4–5 longitudinal beams with three transverse beams; evidence for the soundness of the method is not forthcoming; there is a reference to agreement between the calculated and experimental data.

I. K. Snitko

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

Book—6124. Handbook of multiple buttress dams [Sbornik prác o členených priehradach], Bratislava, Slovenske Vydavatelstvo Technickej Literatury, 1955, 938 pp. + 594 figs. $10.-(Kč 73).

This voluminous handbook is unique in the thoroughness of general description, design and construction of these special types of dams used with great economy all over the world. Authors of 25 chapters are recognized specialists: Chapter 1 by L. Hobst: Structural layout and arrangement, spillways, flood gates. Chapter 2 by L. Hobst, A. Korvas and J. Laudát: Description of various characteristic types, especially those built in Russia and Czechoslovakia. Chapter 3 by K. Lossmann: Foundations of multiple-buttress dams under consideration of various soil conditions. Chapter 4 by K. Lossmann: Main procedures in construction, study of geological conditions, property of water, diversion of streams, installation of construction equipment, mixing and pouring of concrete, supervision during construction, technical and economical evaluation of the dam after completion and during the following years. Chapter 5 by A. Korvas: Organization and mechanical installations on construction site of monolithic dams, transportation of equipments and of building materials, etc., thoroughly discussed in 28 examples. Chapter 6 by L. Hobst: Use of prefabricated (precast) structural parts and their assembly. Chapter 7 by A. Pavlik: Well-organized and effective methods and procedures in manufacturing structural parts of precast reinforced and prestressed parts and structural members; new method of manufacturing such members under lower atmospheric pressure, on the basis of research performed in Russia; properties of vacuum aggregates; lifting and transportation of precast members, and methods of their assembly. Chapter 8 by J. Stork: Technology of concrete, properties of materials and mixed concrete for this type of dams. Chapter 9 by A. Pavlik: Vibration of concrete, its theory and effects on properties and quality of concrete, bond of reinforcement, adhesion between old and new layers, vibration under water and necessary equipment, preferable methods of vibration and test results. Chapter 10 by L. Hobst: Scaffolds and forms. Movable shoring for buttresses, plain and hollow, for interconnecting slabs and shells, supports and bracings, materials of forms (wood, plywood, steel, combination of wood and steel, wire mesh and cloth, effects of forms on quality of concrete, forms with absorbing surface, forms in reinforced concrete. Chapter 11 by L. Hobst: Design of expansion joints in foundation slabs, buttresses and retaining structure, sealing materials. Chapter 12 by L. Hobst: Rigid reinforcement, its advantages and applications. Chapter 13 by L. Mejzlík: Structural design under consideration of all factors of safety and economy; most economical spacing of buttresses and shape of retaining shells, advantages of the Noetzli type. Chapter 14 by L. Mejzlík: Loads to be considered for design, water pressure, static and dynamic, effect of waves and ice, gravity load, uplift, effects of temperature changes and shrinkage of concrete, stresses in foundations, earthquake stresses, combination of maximum stresses with stresses due to mechanical prestressing of the dam. Chapter 15 by K. Konrád: Temperature changes, conductivity of air, water and materials, radiation, reciprocity of radiation of two solid bodies, thermal convection and transmission, their coefficients and analytical expression. Chapter 16 by L. Mejzlík: Determination of stability and safety under various inclination of buttresses. Analysis and its criteria are shown in numerical example. Chapter 17 by P. Peter: Effects of underground water pressure and seepage, and their prevention, spillways, scour pipes; hydraulic disturbances, erosion, effects of freezing, various methods of stabilization, injection of cement and other materials, chemical soil solidification. Examples. Chapter 18 by L. Mejzlík: Analysis of restrained arched shell, with example. Chapter 19 by J. Brilla: Two-hinged arch with three curvatures. Chapter 20 by Z. Čermák and J. Brilla: Analysis of concrete arches restrained in buttresses and foundation slab, under consideration of all possible loadings. Chapter 21 by Z. Čermák: Analysis of the crown structure. Chapter 22 by J. Babuška, Fr. Vyčichlo, Fr. Kroupa and K. Rektorys: Analysis of triangular dams on elastic foundations. Chapter 23 by J. Brilla: Analysis of buttresses. Chapter 24 by L. Mejzlik: Analysis and design of foundations. Chapter 25 by Z. Cermák: Experimental stress analysis. Reviewer's opinion is that this chapter should also describe model testing of buttress dams performed in other countries.

In this handbook only one structure is thoroughly discussed—1:50 model made of gypsum mortar of a four-buttress dam, 60 m (200 ft) high with five arched shells spanning 15 m (49 ft). All measurements were made by R. Nehammer and Valášek. As mentioned in the introduction of this Handbook by Juraj Stork, this was the first model testing of a large structure in Czechoslovakia. Credit is given to J. Valášek and J. Gottwaldová who drew a great number of figures and diagrams. Since Dr. Juraj Stork in his Preface welcomed criticism and discussions, the reviewer believes that a special chapter on steel dams should be included. Buttress dams in steel were designed and built half a century ago in other countries, especially in U. S. (see e.g. the book "Steel dams" by O. E. Hovey, Am. Inst. of Steel Constr., 1935; "Steel facing for dams" by R. T. Logeman, *J. Western Soc. of Eng.* Dec. 1938, "Hráze" (Dams), Technical Encyclopaedia, Prague, 1930, by A. Jílek). Of special interest to Czechoslovak engineers may be that, back in 1933, The Vitkovice Mines, Steel & Ironworks Corp., one of the largest steel fabricators in the world, submitted a competitive bid for a multiple buttress dam in special noncorrosive steel (combined with a concrete composite bridge crossing at the crown). Compare it with 15 bids for dam in reinforced concrete, the steel dam was much cheaper (Kč 5,275 612, compared with Kč 6,732,200 up to Kč 11,105 876). This dam, 110 ft high and 200 ft long, with buttresses spaced 28 ft, was proposed in 1933 on Svratka River at Kníničky, and designed by Prof. G. Krivoshein and Jaroslav Fultner, chief-engineer of Vitkovice Steel Corp. with assistance of professional consultants.

J. J. Polivka, USA

6125. Dyatlovitskii, L. I., and Spirin, G. M., Reduction of the problem with spatial forces of specific gravity to the problem with loaded contour for regions having different elastic constants (in Russian), *Izv. In-ta Gidrol. i Gidrotekhn. Akad. Nauk USSR* **14(21)**, 93–95, 1956; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 13385.

An investigation is made of the plane deformation of heterogeneous elastic bodies subjected to gravity, applicable to gravitational dams lying on rock foundations. The solution is sought in the form of the sum $\sigma = \sigma_1 + \sigma_2$, where σ_1 is the stress in the simplest region, in which there is present the same distribution of spatial forces and elastic constants as in the region being examined, while σ_2 denotes the stresses of the external loading acting on the contour of the region. The problem is solved by the method recorded in the work of M. I. Dlugach [*Prikl. Mekh.* **1**, 1, p. 83, 1955].

M. P. Sheremet'ev

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

Book—6126. Gascoyne, J., Analysis of pipe structures for flexibility, New York, John Wiley & Sons, Inc., 1959, xiii + 181 pp. $7.50.

"Because of the very serious hazards that can accompany plant or pipe failure, rule-of-thumb methods of stress evaluation are no longer acceptable.... It is with the needs of the piping designer that this present volume has been prepared. No attempt has been made to treat any aspects of the subject that are properly the responsibility of the highly-qualified specialist...." (From author's Preface). The structural analysis used in this introductory treatment is elementary in level. The reader is frequently referred to The M. W. Kellog Co.'s exhaustive treatise [AMR **9** (1956), Rev. 1765] for advanced methods and additional information. Chief purpose seems to be to explain the existing piping codes and standards to the beginner, and to acquaint him with the elements of piping engineering.

There are two complete sample analyses. Much code information and tabular material is given in the four appendices.

J. L. Lubkin, USA

6127. Langefors, B., Theory of aircraft structural analysis (in English), *Z. Flugwiss.* **6,** 10, 281–291, Oct. 1958.

Paper gives a rigorous review in purely mathematical terms of some aspects of the matrix force and displacement methods. Author stresses correctly the duality of these two techniques but presupposes that the analysis of a structure by either method is based on the same idealized model, and must hence lead to identical results. In the specific examples given, the idealized system is effectively the standard flange cum shear carrying sheet assembly. While the adoption of such a unique model for both the force and displacement methods is always possible, it does not represent, in reviewer's opinion, a judicious choice in the case of the displacement method. Just as in the matrix force method, the idealization is preferably related to simplified concepts of stress distribution (leading, e.g., to the previously quoted model) so, in the matrix displacement method, the idealization should logically be based on simplified strain or displacement patterns.

Some misconceptions of past work appear, unfortunately, in the paper [see J. H. Argyris and S. Kelsey: "Note on the theory of aircraft structural analysis," *Z. Flugwissenschaften*, **7,** Mar. 1959]. Thus, the previously established more general matrix force and displacement methods do not derive from energy considerations. Also the idealization used in the case of the original matrix displacement method is not identical to that obtained from the finite difference approach. Irrespective of such criticisms, the paper gives in its purely analytical part a valuable and concise presentation of the basic theory. The dual relations for the force and displacement methods are derived from the so-called co-transference theorems. These may only in extremis be considered equivalent to the unit load and distribution theorems developed in previous work. Author discusses very briefly the analysis of structures with cutouts and modifications.

J. H. Argyris, England

Book—6128. Klimov, V. I., Calculations for open shells of the type met with in airplane construction (in Russian) Trudî Mosk. Aviats. In-ta no. 89, 158 pp. + illus., 1957; *Ref. Zh. Mekh.* no. 5, 1958, Rev. 5716.

Approximate methods of calculation are investigated for the strength and deformations of cylindrical and conical shell of small conicity. Cases are examined of torsion and deflection of shells of open and clamped section with free and fastened ends. The transverse section of the shells is assumed to remain unchanged in its plane. Stresses of the membrane type only are taken into account. In the case of shells of small length the basis for the calculations is the hypothesis of shear by V. N. Belyaev. Calculations for long shells are based on the hypothesis of section deplanation. For shells of medium length a combined method of calculations is used, which takes into account both the hypotheses mentioned. The correlation between the stresses corresponding to the hypotheses of shear and deplanation is established by means of the variational method. The problem is examined of the calculations for a shell with fastened transverse section at that portion where a piece has been cut out. Here the portions of the shell with fastened section touching the cut out part are deemed to be absolutely rigid. The methods described in the book for making the calculations are applicable to reinforced or unsupported shells. Many examples of the calculations are reproduced in the text. Supplementary tables form an appendix to the book.

V. A. Martin

Courtesy Referativnyi Zhurnal, USSR

Translation, courtesy Ministry of Supply, England

Machine Elements and Machine Design

(See also Revs. 5932, 5933, 5939, 6142, 6143)

Book—6129. Keck, K. F., The use of gears, Part II. Parallel helical gears. Bevel gears. (Zahnrad Praxis, Teil II. Schragzahnstirnrader, kegelrader), Munchen, Verlag R. Oldenbourg, 1958, 404 pp.

Book treats systematically all points concerning the operation of parallel helical gears, straight bevel gears, and spiral bevel gears. Every chapter contains fundamentals of theory and manufacture. Testing theory in parallel helical gears includes all geometrical relations of the helicoidal involute, dimensions of cutting tools and tooth profiles, gear tooth loading, strength calculations, and profile corrections. Manufacturing gives a clear view of processes from milling to generating, including planing, shaping and hobbing, new methods for spiral bevel gears by Gleason, Oerlikon, Klingenberg, Fiat, etc., and the later innovations of shaving and grinding. Testing contains measurements of cumulative and single errors, testing instruments, mutual influences of various errors.

Theory on straight and spiral bevel gears includes all the developments in tooth forms—such as systems of Gleason, Zerol, Unitook, Klingenberg, Oerlikon-Eloid, etc. — the crown gear as reference size, profile corrections, loading of the gears and strength calculations. Hardening of bevel gears is described. Testing of bevel gears both for straightness and spiral, includes measurements of cumulative and single errors, instruments for testing, etc.

In conclusion author discusses gear-couplings; sample calculations and many tables are included. The book is valuable not only to production engineers but also to designers and to students of mechanical engineering. N. Theophanopoulos, Greece

6130. Beard, C. A., Some aspects of valve gear design, Instn. Mech. Engrs. Auto. Div., Prepr., 3–16, 1958.

Review of velocity and acceleration used in engines relates to forces, stresses and vibration in valve train and its design. Practical considerations are discussed.

C. R. Freberg, USA

6131. Braund, D. F., Torsional vibration, Instn. Mech. Engrs. Auto. Div., Prepr., 17–26, 1958.

In this outline of torsional vibration in engines, relation of critical speeds and torque impulses is indicated. Use of viscous dampers and tuned absorbers is reviewed. Torsional instrumentation and calibration equipment are discussed. This is not a detailed presentation. C. R. Freberg, USA

6132. Clink, R., Balancing of high-speed four-stroke engines, Instn. Mech. Engrs. Auto. Div., Prepr., 27–40, 1958.

Review of balancing methods. Advantages and disadvantages of different arrangements for cranks and counterweights are discussed for in-line and V engines. Tuned absorbers are considered. Practical problems of machine balancing are mentioned.

C. R. Freberg, USA

6133. Spobodkin, M. I., A general method of derivation of the formulae for skew and bevel gears under contact loading (in Russian), *Nauchn. Trudi Mosk. Gorn. In-ta* no. 17, 53-63, 1956; *Ref. Zh. Mekh.* no. 2, 1958, Rev. 2325.

The elementary derivation is given of formulas for calculating the strength of skew and bevel gear wheels under contact shear loading, applying the principle of the equivalent gear wheel. The known formulas for the calculation of spur gears by the principle of the equivalent wheel are extended to the case of cylindrical wheels with skew teeth, and bevel wheels. On page 53 of the paper the dimensions of the torsional moment are incorrectly stated; in the denominator of Eq. [12] under the radical sign, the multiplier m has been omitted; in Eq. [27] the square root appears instead of the cube root.

Yu. P. Grigor'eva

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

Book—6134. Kraus, R., Theory of mechanisms. Vol. III. Mass synthese [Getriebelehre. Band III. Massbestimmung], Berlin, Verlag Technik, 1956, 336 pp.

This is the third volume on "Getriebelehre" published by the author. Following the two first ones—in which rational processes are developed for finding the mechanisms of a degree of liberty and of an imposed fixed member—it deals especially with analytical and graphical methods concerning the "Mass synthese" of "Getriebe."

Chapter A, headed "General consideration," begins with the significance of "Mass bestimmung" which consists in giving to mechanisms such kinematic dimensions as to realize imposed motions or to produce definite forces or moments, or, in a general way, to accomplish given aims. In such mechanisms, called "Getriebe", a driving member transmits forces or moments to a driven member, and, when resistant forces as friction are considered, the notion of efficiency η appears. In this chapter, after some examples of motion transmittion, methods for finding velocities and accelerations, already developed in the two first volumes, are applied to intricate mechanisms. In Chapter B, sliding and screw mechanisms are treated, taking friction into account: driving forces or moments and efficiency η are calculated.

Chapter C, the principal one, is devoted to the "Mass synthese" of the family of four-bar chain and, for this study, the notion of "value balance" (Wertigkeitsbilanz), proposed earlier by the author, is introduced. Author states that to build up a mechanism a succession of "assumptions" (Annahme') must be put together. Each assumption is characterized by its "value," that means the number of coordinates determined by the assumption. A table showing the value of the most useful "assumptions" is given. The possibility of realizing the imposed conditions and of admitting the proposed "assumptions" can be checked with the aid of the value balance. The different mechanisms of the family are then investigated. First are considered those mechanisms in which, successively, two sliders and then one slider are used. Thereafter comes a study of the four-bar chain itself, beginning with particular cases where two members have equal length and going on to the most general disposition.

The kinematic properties of all those mechanisms are the object of a very deeply conducted study using the processes already developed, in their generality, in the two first volumes and applied, in this third one, to the numerous cases here considered. Special mention must be made for the methods based on the properties of the curves representing the geometrical loci of special points: points of the moving plane (Burmesterpoints) which, for four definite positions of the moving plane (the connecting rod in the case of the four-bar chain), lie on a circle; centers of these circles. These geometrical loci are called, respectively, "Kreispunkt Kurve" and "Mittelpukt Kurve" while, when the four positions are infinitely near and tend to a definite position, the loci for each definite position are called "Kreisungspunkt Kurve" and "Angelpunkt Kurve." With the aid of these tools, elegant processes of design are applied to the examined cases. At the end of this chapter, springs are considered in order to assure back motion and balancing.

Chapter D contains a complementary study of the three-member chains already considered in volume I; it concerns the Maltesecross, cams and eccentrics. Motion, velocity and acceleration diagrams are established and problems relating to the determination of spring constants, eccentric curves are resolved. The chains comprising six members are determined in Chapter E. Going on from the five possibilities which are derived from the extension of the four-bar chain, author examines, for each possibility, the kinematic properties with, eventually, their application to function describers, and their practical use as "Getriebe" for given conditions. In Chapter F the application of the Burmester Curves (as explained before), for determining the kinematic dimensions of mechanisms deriving from the four-bar chain, when four position conditions are given, is treated in detail and the calculation of some curves mentioned in Chapter C is developed.

A bibliography of the principal books and papers published on the matter is given at the end of the volume.

This third volume, with the two first ones, to which it steadily refers, constitutes a whole in which the reader will find a clear and thorough view of the actual state of kinematics applied to mechanisms. The third volume will be a valuable tool for all those who wish to go deeply into the study of intricate mechanisms.

D. DeMeulemeester, Belgium

6135. Moroshkin, Iu. F., On the geometry of compound kinematic chains, *Soviet Phys.-Doklady* **3**, 2, 269-272, Dec. 1958. (Translation of *Dokladi Akad. Nauk SSSR (N. S.)* **119**, 1, 38-41, Mar.-Apr. 1958 by Amer. Inst. Phys., Inc., New York, N. Y.)

In conjunction with the author's earlier work [*Trudi Semin. Teorii Mash. Mekh.* **14**, no. 54, 1954], the present paper applies concepts of matrix algebra to the classification of mechanisms. Using Lagrangian coordinates, author develops the number and form of the independent equations of closure characterizing the motion of certain general representations of kinematic chains. The concept of rank is advocated as a natural characteristic of a kinematic chain and equations for the number of degrees-of-freedom are developed.

The application of the above ideas to the analysis and synthesis of real mechanisms would go a long way toward demonstrating their power and usefulness which the reader at present is left to imagine.

F. Freudenstein, USA

6136. Garf, B. A., Revolving mechanisms of movable solar devices (in Russian), Utilization of solar energy, Collection 1, Moscow, Akad. Nauk SSSR, 1957, 62-84; *Ref. Zh. Mekh.* no. 5, 1958, Rev. 5018.

Various kinematic arrangements for the rotation of solar apparatus are described; their comparative characteristics are given. For large-scale installations the most practical appeared to be a doubly supported arrangement with separate azimuth and zenith rotational devices. When calculating the stability of the rotating mechanism, primary consideration has to be given to the loads due to wind pressure; these can be reduced significantly by using special equipment. The question is examined of the control of the system of rotation.

S. G. Kislitsyn

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6137. Jasiulionis, A., An analytical investigation of the kinematics of a crankshaft rocket gear mechanism; The graphic relations of the kinematic and some of the dynamic properties (in Russian), *Trudī Lit. S.-kh. Akad.* **3**, 37-101, 1957; *Ref. Zh. Mekh.* no. 5, 1958, Rev. 5032.

A description is furnished of the investigations (kinematic and dynamic) of plane rocket gear mechanisms with various geometrical parameters. A large number of diagrams is produced, which very considerably simplify the investigation of a mechanism with assigned parameters.

V. A. Zinov'ev

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6138. Verstakov, G. V., A method and examples of the calculations for the strength of the outer walls of the drums of mineshaft winding machines (in Russian), *Nauchn. Trudī Molotovsk. Gorn. In-ta* no. 1, 77-79, 1956; *Ref. Zh. Mekh.* no. 4, 1958, Rev. 4785.

It is proposed to carry out the calculations for the strength of the walls of the drums of winding machines by viewing the drum as an axially symmetrical round cylindrical shell. In order to determine the specific pressure P of the cable on the shell, based on B. A. Morozov's formula [TsNIITMASh, 1949, book 27] graphs were drawn up for the values of the coefficients C and λ, which enter into the expression for P. By making use of the known solution for a cylindrical shell, clamped along the outline of the faces, author brings in formulas for the determination of the deflection moments, the transverse forces and the displacements in the sections of the shell. When doing this, the deformation of the flanges of the drum is disregarded. The solution is demonstrated for cases of continuous and of partial even loading of the shell along its length. In the second case of loading, distributed over part of the length of the drum, the proposal is made to substitute for this type of loading a load distributed over the whole length (of the drum), having an intensity calculated by formulas which are given but not deduced. For the shell reinforced by bands, the author proposes to calculate stresses by substituting for it a shell of equivalent rigidity but without bands. Expressions are given for the determination of the thickness of such a shell. In the author's view, the proposed method gives values for the deflections and stresses closer to the actual than B. A. Morozov's method, in use at the present time. Paper ends with a schedule for the calculations for the drum by the method proposed by the author, and three examples are also given for the determination of the stresses.

D. E. Iskritskii

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6139. Sanikidze, V. K., The problem of automatically stabilizing the vertical position of a self-propelled mining machine (in Russian), *Sb. Tr. Tbilissk. In-ta Inzh. Zh.-d. Transp.* no. 30. 183-198, 1956; *Ref. Zh. Mekh.* no. 2, 1958, Rev. 1595.

An investigation of the dynamics of a self-propelled mining machine (stoper) intended for working in steep slopes. It is recommended to stabilize the vertical attitude of the machine by means of a transmission spring and a reversing stabilizer. The conclusion drawn in the paper, that the angular coefficient of the characteristic of the elastic link must be determined from the condition of tangency to the curve of variation of the folding moment, depending on the change in the angle of the slope, is erroneous; to ensure steady working at the point of equilibrium, the spring should have a harder characteristic. The condition of equilibrium itself, on the other hand, will only enable determination of the necessary load of the elastic member, not of its resilience.

A. A. Pervozvanskii

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6140. Epstein, Yu. V., and Steinolf, L. I., The optimum form for rotating counterweights (in Russian), *Trudī In-ta Mashinoved. Akad. Nauk SSSR, Sem. Teor. Mash. Mekh.* **15**, 57, 47-60, 1955; *Ref. Zh. Mekh.* no. 2, 1958, Rev. 1602.

It is proposed to evaluate the optimum form and dimensions of counterweights for machines with a periodic curve of the referred mass (e.g., vibrating conveyors, shaker screens, etc) by the magnitudes of the minimum mass m, or minimum moment of inertia I, of the counterweight with reference to the axis of rotation. These two conditions do not coincide. It is demonstrated that the problem of reducing the amplitude of the resonance vibrations of the machine when starting and running down can be reduced to the problem of determining the counterweight with the minimum moment of inertia with which starting and running down are of least duration. The mathematical conditions are stated for the determination of m, I, and the form of the counterweight for some particular cases with consideration of structural limitations on the design.

V. N. Geminov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6141. Zaytsev, V. N., The calculation of multiple-ring rotors for steam turbines (in Russian), *Uch. Zap. Leningrad Vyssh. Inzh. Morsk. Uch-shche* no. 4, 68-72, 1957; *Ref. Zh. Mekh.* no. 2, 1958, Rev. 1770.

The equations derived by the author enable the solution of a number of different problems encountered in the design calculation of double-ring rotors; in particular, to determine the degree of reaction in the rotor blade rings corresponding to assumed dimensions of the working section.

V. Kh. Abiants

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

Fastening and Joining Methods

(See also Rev. 6066)

6142. Donald, M. B., and Salomon, J. M., The behaviour of narrow-faced, bolted, flanged joints under the influence of internal pressure, Instn. Mech. Engrs., Auto. Div., Prepr., 3-7, 1958.

A narrow-faced, bolted, flanged joint is a highly complicated stress-system. When internal pressure is applied, the stress-system changes. In order to establish, quantitatively, what these changes are, a series of experiments were carried out on a pair of 2½-in. nominal bore screw-on hubbed flanges.

The apparatus was assembled as shown by authors in a previous paper. An accurate measure of bolt stress and, hence, the stress on the gasket was obtained by attaching a total of four electric resistance strain gages to two "measuring" bolts. As the nuts were all tightened carefully by means of a torsion wrench, an average of the readings of the four gages gave the average bolt stress of the eight bolts.

Care was taken that the gages were cemented diametrically opposite sides of the bolts and that two of the gages were pointing toward the center of the flange while the other two were pointing in the opposite direction. From the readings of the two pairs of strain gages it was possible to calculate the extent of bending of the bolts during application of internal pressure and, hence, the rotation of the flange-rings due to pressure.

The results of the experiments indicated:

A (1) There is a linear relationship between bolt load and internal pressure.
(2) The slope of the line giving this relationship depends on the elastic properties and the dimensions of the components of the joint.
(3) This slope can be predicted mathematically.
(4) This slope can, in the case of pseudo-elastic gasket materials such as compressed asbestos composition, be positive, negative, or zero; the slope in any particular joint depending only on the initial load on the gasket.

B (1) The rotation of the flange rings due to pressure increases as the slope of the bolt load *versus* internal pressure line changes from negative to positive.

(2) The rotation as calculated from strain-gage measurements agrees fairly well with that calculated by use of the theory of Wesstrom and Bergh.

C The circumferential strain in the flange and pipe assembly is at a maximum in the pipe at the back of the hub. This result is in agreement with that reported by several other investigators and is not discussed in this paper.

From authors' summary

6143. Toth, G., and Waigand, F., Strength of belting leather under continuous strain (in Hungarian), *Magyar Tud. Akad. Musz. Tud. Oszt. Köz.* **22**, 1/3, 107–116, 1958.

6144. Danilov, S. A., Calculations for welded seam stresses of bending bars fitted with angled insertions and fresh welding (in Russian), *Trudi Leningr. Korablestroit. In-ta* no. 19, 41–60, 1956; *Ref. Zh. Mekh.* no. 5, 1958, Rev. 6102.

The principle of boundary loads is applied to working out the calculations for a welded joint of bending bars, for instance for a beam with a column, joined by means of triangular insets, welded there and then. From author's summary

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6145. Edels, H., and Gambling, W. A., Excitation temperature measurements in glow and arc discharges in hydrogen, *Proc. Roy. Soc., Lond. (A)* **249**, 1257, 225–236, Jan. 1959.

An experimental program to measure excitation temperatures in glow and arc discharges in various pressures of hydrogen was performed. The temperatures were determined from measurements of relative intensities of spectral lines in the Balmer series for hydrogen. By plotting the excitation temperatures from the $\alpha\,\beta$ and $\beta\,\gamma$ transitions versus current at a fixed hydrogen pressure in the discharge, it was found that minima existed in temperature versus current curves. The minima were found to always coincide with the occurrence of the column constriction, and the temperatures at which the minima occurred were constant for all pressures of hydrogen which were investigated. Authors conclude that the constant minimum values of the excitation temperatures when column constriction occurs present strong evidence in favor of a thermally dependent mechanism of arc column formation.

In addition to the region where nonthermal equilibrium exists, the region where $T\alpha\beta = T\beta\gamma$ and thermal equilibrium becomes possible was investigated. Application of the Saha equation to this region of the discharge did not predict the observed ion densities, and it was concluded that the Saha equation is not applicable to the newly formed low-current arc column.

C. A. Alexander, USA

Rheology

(See also Revs. 6172, 6262)

6146. Slibar, A., and Paslay, P. R., Retarded flow of Bingham materials, *J. Appl. Mech. (Trans. ASME,* Series E) **26**, 1, 107–113, Mar. 1959.

Solutions are obtained for retarded flow of a jelling Bingham-type material for the cases of flow between sliding parallel plates, between concentric cylinders, and through a circular cylinder. The analysis shows that in the case of flow between rotating concentric cylinders the entire mass of the material undergoes deformation. In the case of laminar flow through a circular cylinder, however, only part of the material deforms and a central core moves as a rigid body, thereby giving plug flow. Curves relating load to deformation rate are given for these two cases. These curves are dependent on the loading path and, in the case of flow through a cylinder, the sign of the radius of curvature is different for the loading and unloading branches.

Reviewer believes that this paper will be of interest not only to rheologists but also to those concerned with such practical problems as the behavior of grease-lubricated bearings during intermittent operation and phenomena occurring during shut-downs in oil well drilling. J. W. Givens, USA

6147. Kestlicher, D., On the flow of "non-Newtonian" liquids (in French), *Rev. Univ. Mines* (9) **14**, 8, 245–258, Aug. 1958.

An exposition is given of the flow of liquids for which the Newtonian supposition, shear stress proportional to velocity gradient, does not hold. Vaious types of such non-Newtonian flow are detailed, and a description given of a concentric cylinder apparatus used in industry for obtaining data on apparent viscosity and yield value. Equations are given showing the use of such data for deriving values for the resistance of suspensions flowing in pipes.

A useful survey of the field, though most of the material will be familiar to the practising rheologist.

E. G. Richardson, England

6148. Gupta, A. S., On the flow of a visco-elastic fluid past a porous flat plate (in English), *J. Sci. Engng. Res., India* **2**, 2, 221–226, July 1958.

Author derives exact solution for flow of an incompressible Maxwell body past an infinite flat plate with fluid injection. He also derives approximate solutions for a compressible Maxwell body. It is hoped that the use of the more general term "visco-elastic fluid" when a Maxwell body is meant will not cause confusion.

S. Gratch, USA

6149. Jain, M. K., The stability of certain non-Newtonian liquids contained between two rotating cylinders (in English), *J. Sci. Engng. Res. India* **1**, 2, 195–202, July 1957.

Equations of motion for fluid showing cross-viscosity are applied to case of rotational Couette flow, for which velocity is $V = Ar + B/r$, with r the radius. The neutral stability of perturbations in such flows is determined with Chandrasekhar's variational technique. The critical Taylor number is found to be increased appreciably (8%) above the classical value for one value of a dimensionless cross-viscosity parameter. Non-Newtonian effects are thus shown to be stabilizing.

It is unfortunate that no indication is given of the manner in which the critical condition varies with the cross-viscosity parameter nor of the reasonableness of the particular value chosen for calculation. J. M. Robertson, USA

6150. Barnes, G., and MacKenzie, J., Height of fall versus frequency in liquid rope-coil effect, *Amer. J. Phys.* **27**, 2, 112–115, Feb. 1959.

Authors consider coiling effect of thin streams of viscous liquids falling vertically on to flat horizontal surfaces. A linear relationship is derived experimentally between height of fall and frequency of coiling. A correction made for the effect of surface tension gives an "effective" height of fall which is directly proportional to the coiling frequency. No physical explanation is given for this relationship. R. N. Cox, England

6151. Torre, C., On the motion of plastic mass (in English) *Öst. Ing.-Archiv* **12**, 1/2, 25–36, Sept. 1958.

"Plastic mass" considered by author seems to be an inelastic although compressible body, endowed with viscosity, even bulk viscosity, and with a yield limit. By means of various formal simplifications, this material can be boiled down to the well-known rigid-perfectly plastic body.

As examples, author treats torsion of a circular cylinder and a general problem simultaneously characterized by plane stress and plane flow. In one instance, the material is supposed to be incompressible though subject to a yield condition predicting yield under hydrostatic pressure. In another instance, even a yield condition expressible in velocity components is used.

H. H. Ziegler, Switzerland

6152. Kolar, V., Spiral motion of fluids (in English), *Rozpravy Československé Akad. Věd* **66**, 5, 105–118, 1956.

Hydraulics

(See also Revs. 6122, 6234, 6238, 6242, 6245, 6256, 6379, 6391)

Book—6153. Mkhitarian, A. M., Hydraulics and hydromechanics [Gidravlika i gidromekhanika], Kiev, Ukrainian Gostekhizdat, 1958, 374 pp. $1.80.

Approved textbook for mechanical engineering students in Ukraine, book contains usual chapters on hydraulics, rather fluid mechanics, and fundamentals of hydromechanics, including theoretical hydrodynamics, vortex theory, similarity, boundary layer, wing theory and others. At the end, seven most important laboratory tests are presented in general principles. A list of literature contains 111 titles, including 98 Russian, 1 Armenian, no Ukrainian, and 12 books translated from English and German, among them Bakhmeteff, Durand, Prandtl and Tietjens, Lamb, Nikuradse, Hilton, Howart, Forchheimer, etc. Text and print are good. Author dedicated his book to the 60th anniversary of the Kiev Polytechnical Institute.

S. Kolupaila, USA

Book—6154. Mostkov, M. A., Hydraulics [Gidravlika], Moscow, Gos. Transzheldroizdat, 347 pp. $1.60.

The first, posthumous edition (author died in 1956) of a standard textbook for special schools. It contains usual chapters, including nonuniform flow in open channels and ground water flow. General impression is good; sketches are particularly clear. There are no problems. Hydraulic Manual, published by author in 1954, has been translated into German and issued in Berlin in 1956.

S. Kolupaila, USA

Book—6155. Agroskin, I. I., Hydraulic design of canals [Gidravlicheskii raschet kanalov], Moscow, Gosenergoizdat, 1958, 80 pp. $0.50.

This little booklet is a practical manual for designing cross sections for canals. Trapezoidal, parabolic and circular sections are treated. Author applies his method of dimensionless ratios, introduced in 1940. Limits of velocity to eliminate scour and silting follow Russian standards. Tables for direct determination of the size of canals conclude this useful publication.

S. Kolupaila, USA

Book—6156. Mostkov, M. A., Outline of a theory of channel current [Ocherk teorii ruslovogo potoka], Moscow, Izd. Akademii Nauk SSSR, 246 pp. $1.90.

Late scientist of Georgia (author died in 1956) presents, in this carefully edited booklet, general laws of natural turbulent currents, interaction between the stream and movable bed, and motion of two-phase current carrying sediments and entrained air. Stream movement phenomena in bends, a shifting equilibrium, training of bottom sediment, mud currents and silting of reservoirs, are only a few among many interesting and practically important problems treated in this posthumous work. Other publications of Prof. Mostkov have been reviewed in AMR. [AMR **11** (1958), Rev. 4081; **12** (1959), Rev. 824].

S. Kolupaila, USA

Book—6157. Johnson, J. W., and Wiegel, R. L., Investigation of current measurement in estuarine and coastal waters, Sacramento, Calif., State Water Pollution Control Board, 1959, xi + 233 pp. $1.75.

This thorough study reviews all known instruments for sea current measurements: with rotating element, drift type, dynamic, geomagnetic, electromagnetic, ultrasonic, hot-wire and other types. Introduction gives general character of ocean currents and idea of determination of coastal and estuarine currents. Data recording is shown on official forms of different institutions. Cost data are mentioned in an appendix. A bibliography of 28 pages ends this very valuable temporary publication. Reviewer regards it as important that this book, unique in its field, be published in final form with more perfect reproduction of numerous figures and pictures.

S. Kolupaila, USA

6158. Scholer, H. A., and Germanis, E., Unsteady flow in rivers and artificial canals, *Instn. Engrs., Australia, Civ. Engng. Trans.*, **CE 1**, 1, 27–37, Mar. 1959.

Mathematical solutions of unsteady flow problems in open channels are infrequently attempted because of the complexity and volume of the computations necessary. In this paper authors derive the general equations for both simple and branched channels and set up the solutions by the method of characteristics. The solution of a typical river tidal problem by the use of a digital computer is given in detail. Savings in time over other computing methods and in cost over standard model methods are claimed.

D. G. Huber, Canada

6159. Perel'man, R. G., and Polikovskiĭ, V. I., Hydraulic resistance of rectilinear channels in a centrifugal force field (in Russian), *Izv. Akad. Nauk SSSR, Otd. Tekh. Nauk* no. 10, 150–153, 1958.

Friction coefficient and velocity distribution were investigated in brass pipes of 10, 20 and 28-mm diameter, located radially on a centrifuge and rotated 100 to 400 rpm. Air was pumped from the center to the periphery or back; pressure difference was measured in series of U-shaped manometric tubes, mounted on a cylindrical panel which was rotated together with pipes. Exposition of 1/1000 sec fixed manometer readings on a film. Experiments showed that the friction coefficient increases with decreasing Reynolds number, with increasing speed of rotation and with the magnitude of centrifugal force. Velocity distribution across the pipe was substantially different from the normal conditions without centrifugal force. Velocity gradient at the walls becomes greater, the velocities in the core are almost uniform. Correction formula was derived to the familiar Blasius formula for smooth pipes.

S. Kolupaila, USA

6160. Pokhsrarian, M. S., On the question of damping of transverse circulation, *Soviet Phys.-Doklady* **3**, 2, 262–265, Dec. 1958. (Translation of *Doklady Akad. Nauk SSSR (N. S.)* **119**, 2, 233–236, Mar.-Apr. 1958 by Amer. Inst. Phys., Inc., New York, N. Y.)

Author presents theory and test results for damping of transverse circulation in reaches below curved sections of rivers for various width-depth ratios and channel roughnesses. Damping is more intense in rough channels and in narrow channels.

J. C. Geyer, USA

6161. Alford, J. S., Inlet flow distortion index (in English), C. R. Journées Internationales de Sciences Aéronautiques, Paris, May 27-29, 1957; Paris, ONERA, Part I, 71–94.

6162. Gumbel, E. J., The statistical theory of low water discharges (in French), *Houille Blanche* **14**, 1, 57–64, Jan.-Feb. 1959.

6163. Chou, T.-L., Resistance of sewage sludge to flow in pipes, *Proc. Amer. Soc. Civ. Engrs.* **84,** SA 5, part I, (*J. San. Engng. Div.*), Pap. 1780, 19 pp., Sept. 1958.

Incompressible Flow

(See also Revs. 6148, 6149, 6150, 6152, 6210, 6216, 6245, 6257, 6262, 6283, 6289, 6297, 6309, 6329)

6164. Pierce, J., Hess, J. L., and Smith, A. M. O., Velocity distributions and shapes for free streamline bodies having wedge-shaped noses, Douglas Aircr. Rep. ES-29123, 50 pp., Aug. 1958.

Using results of Plesset and Shaffer [*Navord Rep.* No. 1014, Oct. 6, 1949] on the free-streamline flow past a finite wedge, calculations are made of the velocity distribution on the surface of the wedge and of the shape of the free streamline. A parametric representation of these quantities is obtained in terms of the semi-vertical angle of the wedge and V_{max}/V_{∞}, where V_{max} is the velocity on the free streamline and V_{∞} is the free-stream velocity.

W. H. Pell, USA

6165. Petukhov, B. S., and Krasnoschekov, E. A., Hydraulic resistance in the case of viscous non-isothermal flow of liquid in tubes, *Soviet Phys.-Tech. Phys.* **3,** 6, 1123–1129, Feb. 1959. (Translation of *Zh. Tekh. Fiz., Akad. Nauk SSSR* **28,** 6, 1207–1214, June 1958 by Amer. Inst. Phys., Inc., New York, N. Y.)

Results of an experimental study of hydraulic resistance in the case of viscous (laminar) nonisothermal flow of liquids in circular and rectangular tubes are given. A generalized expression for the resistance coefficient valid when the viscosity varies widely over the flow cross section is calculated.

From authors' summary

6166. Kuwabara, S., The forces experienced by a lattice of equal flat plates in a uniform flow at small Reynolds numbers, *J. Phys. Soc. Japan* **13,** 12, 1516–1523, Dec. 1958.

Referring to the publications by T. Tamada and H. Fujikawa [AMR **11** (1958), Rev. 2678], T. Miyagi [AMR **12** (1959), Rev. 265], H. Hashimoto [AMR **12** (1959), Rev. 263], and K. Tamada, author examines the two-dimensional flow of viscous fluids through a straight lattice of infinitely thin plates (profile length = 2). The axis of the lattice is at right angles to the speed of the uniform flow, and the plates are at right angles to the axis of the lattice.

Using Stokes's approximation and Fourier's transformation, author calculates the resistance of the plates. Numerical solutions are obtained for the two special conditions involving infinitely large and infinitely small distances (h) between two neighboring plates. The first solution applies approximately to $h > 5$. For $h < 5$ the second solution provides resistance values which are slightly too low, but for $h \approx 5$ the results agree satisfactorily with those of the first solution.

M. Strscheletsky, Germany

6167. Wadhwa, Y. D., Steady slow rotation of two spheres in a viscous liquid (in English), *J. Sci. Engng. Res., India* **2,** 2, 245–250, July 1958.

Two spheres are in slow rotation about their line of centers in a viscous liquid. By using coaxal coordinates, author calculates the torques (1) when each sphere is external to the other, (2) when one sphere is rotating inside another rotating sphere, and (3) when one sphere is rotating near a rotating infinite disk.

L. M. Milne-Thomson, USA

6168. Paskalew, G., and Tschobanow, I., Exact solution of the Navier-Stokes equations in a semi-space covered with sources (in German), *Z. Flugwiss.* **6,** 7, 199–203, July 1958.

Authors consider the problem of the motion of an incompressible viscous fluid in a semispace in presence of a perpendicular axis covered with equally distributed sources of constant strength. For some values of parameters, C. Schmieden and K.-H. Müller [AMR **10** (1957), Revs. 774, 1147] had already shown the existence of closed-form solutions. Authors now give a great number of further cases in which a closed integration of the Navier-Stokes equations of fluid motion is possible and analyze a part of these solutions.

F. Engelmann, Germany

6169. Muller, H., Contribution to the question of steady movement in hydrodynamics (in German), *ZAMP* **9a,** 4, 389–392 (Brief Reports), Nov. 1958.

According to a theorem stated by Von Helmholtz and Korteweg, when the inertia force terms may be neglected, the steady motion of a viscous fluid under constant extraneous forces having a single-valued potential dissipates less energy than any other motion having the same values of velocity at the boundary.

This theorem is extended to the motion of a single macromolecule model in a nonhomogeneous field of flow.

D. Gh. Ionescu, Roumania

6170. Oskay, V., Analysis of two flow fields in nondissipative interaction, Air Force Contract no. 18(603)-37, (Rensselaer Polytech. Inst. Aero. Engng. TR AE5711), 42 pp., Jan. 1958.

6171. Vakharev, V. A., Possibility of a generalization of the mechanism of laminar and turbulent motions (in Russian), *Nauchn. Trudi Kazansk. In-ta Inzh.-stroit. Neft. Prom-sti* no. 4, 113–118, 1956; *Ref. Zh. Mekh.* no. 5, 1958, Rev. 5531.

Expressions are put forward for the velocity profile and for the resistance coefficients of a flow of liquid obtained from a generalized expression for friction, on the assumption that the coefficient for the virtual viscosity is expressed by a function corresponding to the almost constant value it has in the nucleus of the stream, with rapid decrease near the wall up to a value equal to that of molecular viscosity. For the case of a laminar flow the expressions obtained are given in the generally-known form.

B. A. Fidman

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6172. Langlois, W. E., Creeping viscous flow through a two-dimensional channel of varying gap, Proc. Third U. S. Nat. Congr. Appl. Mech., June 1958; Amer. Soc. Mech. Engrs., 1958, 777–783.

The slow flow under pressure of a very viscous, incompressible, inelastic fluid through a two-dimensional channel of nonuniform gap is investigated theoretically. Three approximation methods are developed and compared. The flow from one uniform channel to another of smaller gap through a smooth constriction is considered in detail.

From author's summary

6173. Cooper, Alfred R., Jr., Mixing and flow in glass tanks, *J. Amer. Ceram. Soc.* **42,** 2, 93–101, Feb. 1959.

Mixing influences that are effective during the flow of glass through continuous tanks are classified. Common experimental techniques for evaluating these influences are compared. A multicell model is used to describe flow behavior in the absence of mixing from transfer flow. Laminar transfer flow in a glass tank is evaluated by considering flow through an open channel with a vertical viscosity gradient. Recently published results describing flow through a container glass tank at relatively high pulls are best explained by secondary flows modifying the mixing effects from the variable velocity of laminar transfer flow through the tank.

From author's summary

6174. Galperin, N. I., and Pebalk, V. L., An investigation of the aerodynamic resistance to the motion of a binary phase system in a vertical pipe (in Russian), *Trudi Mosk. In-ta Tonkoi Khim.*

Tekhnol. no. 6, 93–104, 1956; *Ref. Zh. Mekh.* no. 2, 1958, Rev. 2008.

In order to investigate the loss of head in the motion of a system consisting of a liquid and solid particle, in application to the conveying of coal, a special installation was assembled, consisting of a vertical metal pipe, a cyclone, bunkers, and a feed worm. The air blast from a fan was introduced from below, picking up particles introduced from above, and conveying them through the pipe to the cyclone. The quantity of coal and air fed to the tube, and the pressure gradient across the top and bottom points of the tube, were measured. From an evaluation of the experimental results and certain theoretical considerations, an equation has been derived for the coefficient of resistance (drag coefficient) in the vertical sections of a pneumatic conveyor. The values of this drag coefficient, calculated from the derived formula, differ from the experimental values by 5 to 7%. The possibility is indicated of working the elevator with introduction of a subsidiary flow of the comminuted material at an intermediate cross section along the height of the pipe. U. Ts. Andres

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6175. Efros, D. A., The displacement of a two-component mixture when the viscosity of one of the fluids being displaced is low, *Soviet Phys.-Doklady* **3,** 4, 727–731, Apr. 1959. (Translation of *Doklady Akad. Nauk SSSR (N. S.)* **121,** 1, 59–62, July–Aug. 1958 by Amer. Inst. Phys., Inc., New York, N. Y.)

Flooding of boreholes causes displacement of a mixture of gas (1) and oil (2); the infiltration of water (3) leads to the formation of a region with a three-component flow at constant field pressure. Considering the conditions of the flow in an elementary tube of constant shape and assuming incompressibility of the fluids and continuity, author gives the solution of equation for distribution of oil saturation as function of tube length and time. Saturation is found from material balance equation. Calculations show that the liquid with low viscosity is displaced; its quantity behind the displacement face approaches the minimum residual content. The presence of a third, bound component can be taken equivalent to a corresponding reduction of porosity. At the interface of fluids (2) and (3) there is a step in the saturation. The distribution of saturations reveals the presence of three regions: two two-component flows, one of them being divided by a region of single-component flow. The latter expands in time and the moving part of the low-viscosity component is extracted almost entirely, after which fluid (2) is displaced by fluid (3). The flow of this type has been confirmed by experiments on the displacement of oil by water in the presence of free gas. The use of relations for saturation of the two-component flow gives a satisfactory agreement with the experiments. A. Kezdi, Hungary

6176. Efros, D. A., and Allakhverdiyeva, R. A., The calculation of the limiting non-aqueous discharges of imperfect boreholes by analog data (in Russian), *Trudi Vses. Neftegaz. N.-i. In-ta* no. 10, 101–130, 1957; *Ref. Zh. Mekh.* no. 2, 1958, Rev. 2017.

To determine the maximum nonaqueous discharge from a borehole, the analog of the steady-state, radial motion of two liquids through a slit flume is applied, the system petroleum-water being modelled by a system oil (volume density 0.885 g/cm³)—glycerine (volume density 1.24 g/cm³). In accordance with the proof given by V. I. Aravin [*Izv. N.-i. In-ta Gidrotekhniki*, 1938, **23**] for the case of a radial flow, the law of variation of the thickness of the slit δ over a distance R, is assumed in the form

$$\delta = \sqrt[3]{aR} \qquad a = \text{const.}$$

The slit was formed between two walls of vitreous plastic. Because of the great variation in density of the oil in the presence of temperature fluctuations, the model was placed in a thermostatically-controlled chamber. Verification showed that the divergence in the overall permeability of the slit, calculated over its thickness (width) and determined directly, was 1%. In the immediate vicinity of the bore, however, the scattering of the piezometer indications was greater. The maximum nonaqueous discharge was assumed to be equivalent to the discharge of the liquid (oil) at which the glycerine entered the bore in a quantity of 1% of the total volume of the liquids. The experimental results have been evaluated in the form of generalized curves. It is pointed out that the discharge values sought are little dependent on the radius of the bore-hole, but no clear proof of this statement is given. Further, in order to determine the variation in the nonaqueous flow with time, the unsteady process of exhaustion of a deposit was investigated. For this purpose, the method of successive variation of the steady state was applied, it being assumed that, at each instant of time, the ordinates of the depression curve correspond to the experimental values obtained with a slit flume. The method of conversion for the case of an anisotropic medium is explained. V. M. Shestakov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6177. Assatur, K. G., and Gerontyev, V. I., The investigation of undrowned jets by the method of high-speed cinematography (in Russian), *Izv. Akad. Nauk SSSR, Otd. Tekh. Nauk* no. 3, 164–167, 1957; *Ref. Zh. Mekh.* no. 2, 1958, Rev. 1845.

To investigate the propagation of liquid jets in air, a method of high-speed cinematography has been used which enables the jet structure to be investigated in detail. A formula has been derived by which the order of magnitude of the jet representing the limit for obtaining an unblurred cinephotograph can be determined. An arrangement is described which was used for producing jets of water issuing into air at different velocities. Some photographs are presented of water jets; these photographs proved sufficiently clear to determine the structure of the jet, its velocity, and the velocity profile across the transverse section of the jet. Yu.F. Dityakin

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

Compressible Flow (Continuum and Noncontinuum Flow)

(See also Revs. 6148, 6209, 6221, 6223, 6226, 6227, 6245, 6263, 6267, 6271, 6293, 6294, 6318, 6321, 6322, 6325, 6340, 6341, 6373)

6178. Toong, T.-Y., and Kaye, J., Theoretical solutions for a steady laminar flow of a compressible fluid in the entrance region of a tube (in English), 9th Congrès Intern. Mécan. Appl., Univ. Bruxelles, 1957; **4,** 30–42.

Paper gives improved numerical results to the same problem analyzed in AMR **9** (1956), Rev. 570. G. Moretti, USA

6179. Moriguchi, H., A new approach to the theory of slender body in compressible flow, *J. Phys. Soc. Japan* **13,** 11, 1384–1398, Nov. 1958.

This paper is concerned with the approximate solution of the equations for steady subsonic flow past either a two-dimensional or axisymmetric body. It is first supposed that the solution for such a flow past a given body is known. It is then shown that the equation for the perturbations from the known flow can be written in a simple form by choosing the streamlines and equipotential surfaces as coordinates. Approximate solution of the resulting equation for the case of a slender body leads to the following ve-

locity transformation formula

$$\int_U^q \frac{\sqrt{1 - q^2/c^2}}{q}\, dq = \ln \left(\frac{q}{U}\right)_i$$

when q, c, and U are the local velocity of fluid, the local velocity of sound, and the velocity of the free stream. The subscript i refers to the values for the corresponding flow of an incompressible fluid.

This formula has been given earlier by Imai for two-dimensional flow and by Kusukawa for axisymmetric flow, but the present derivation has the advantages that the boundary conditions are satisfied exactly rather than approximately, and that higher-order approximations for the solution may be obtained by iteration.

The author notes that the approximate solution leading to the above velocity transformation formula requires the omission of a term that is of second-order importance in the two-dimensional case, but of first-order in the axisymmetric case. This requirement undoubtedly accounts for the fact that this formula leads to results that agree very well with other theoretical and experimental results for two-dimensional flow, but that overestimate the variation of the maximum velocity with Mach number for axisymmetric flow. J. R. Spreiter, USA

6180. Paddison, D. I., The constant-current hot-wire anemometer in subsonic compressible flows, AFOSR TN 58-713 (Brown Univ., Div. Engng., TR WT-29; ASTIA AD 162 248), 37 pp., Aug. 1958.

Measurements have been made of the heat-loss from heated tungsten wires of 0.00015-inch and 0.00035-inch diameter over a range of Mach numbers from 0 to 1.05 and Reynolds numbers from 1 to 36.

The sensitivities of a constant-current hot-wire anemometer to fluctuations in subsonic flows are presented and some aspects of the use of the instrument are discussed.

From author's summary

6181. Martensen, E., and von Sengbusch, K., Numerical representation of two-dimensional and axially symmetrical transonic nozzle flow with curved transition (in German), *Mitt. Max-Planck Inst. Stromungsforschung* no. 19, 113 pp., 1958.

Numerical calculation of transonic flow in the vicinity of the throat of a two-dimensional and axisymmetric Laval nozzle with linear velocity distribution by means of power-series expansion with respect to the co-ordinate variables. Estimation of domain of convergence of the series is made in case of two-dimensional nozzle. Numerical tables of flow variables, stream line, sonic line, etc., obtained by electronic computer are given as well as tables of initial characteristics for use of supersonic nozzle design by means of method of characteristics.

R. Kawamura, Japan

6182. Shmyglevskii, Iu. D., Supersonic profiles with minimum drag, *Appl. Math. Mech. (Prikl. Math Mekh.)* **22,** 2, 368–374, 1958. (Reprint order no. PMM 33, Pergamon Press, 122 E. 55th St., New York, 22, N. Y.)

Paper shows a method to determine for plane supersonic flow the front part of a profile that has minimum drag at given length and thickness ratio. Essential is the choice of a characteristic as control surface for mass flow and momentum; this choice leads to a one-dimensional variational problem. The profiles obtained are practically wedges with straight sides; theoretically minute deviations exist. Method is closely related to papers by reviewer and by Rao [AMR **10** (1957), Rev. 1520 and AMR **11** (1958), Rev. 5051]. K. G. Guderley, USA

6183. Lord, W. T., and Brebner, G. G., Supersonic flow past slender pointed wings with "similar" cross section at zero lift, *Aero. Quart.* **10,** 1, 79–102, Feb. 1959.

Slender-body theory is used to study the wave drag and pressure distribution for pointed wings of arbitrary planform and cross-section shape with sharp edges. The problem of achieving low wave drag is considered, and for purposes of comparison results on wave drag and root pressure distribution are tabulated for nine different wings. P. R. Garabedian, USA

6184. Graham, E. W., and Licher, R. M., The calculation of interference drag between wing lift and fuselage thickness at supersonic speeds, Douglas Aircr. Co. Rep. SM-23446, 23 pp., Feb. 1959.

It is known that, for the monoplane, the high-wing configuration often offers more possibility of drag reduction than do the mid- or low-wing versions because of favorable interference between wing lift distributions and the fuselage thickness. In this report a particular case of an elliptical planform, zero thickness wing combined with a Sears-Haack fuselage is studied to determine the variation of drag with wing height above the fuselage centerline. This configuration is chosen in order to simplify the drag calculations, and, to further simplify the calculations, the wing height above the fuselage is assumed to be small with respect to the wing chord.

The method of analysis applies both when the wing lies within the Mach envelope of the fuselage and when it extends outside the envelope. For both cases the drag values obtained for the high wing are compared with those for the mid-wing configuration. The first case (wing within the fuselage envelope) has been studied previously, and the present results are consistent with those obtained earlier. The results in the second case are believed to be new. From authors' summary

6185. Gold, Ruby, and Holt, M., Calculation of supersonic flow past a flat-headed cylinder by Belotserkovskii's method, AFOSR TN 59-199 (Brown Univ., Div. Appl. Math.; ASTIA AD 211 525), 28 pp., Mar. 1959.

Belotserkovskii's method of calculating the supersonic flow past a circular cylinder is applied to the case of a flat-headed cylinder. The surface pressure distribution and associated flow field (including the shape of the detached shock wave) are determined for a prescribed incident Mach number. Only the first approximation of Belotserkovskii is considered. Selected physical variables are assumed to vary linearly between the body and the shock, thereby reducing the original problem to one of solving three ordinary differential equations. The boundary conditions are obtained from symmetry conditions on the axis of symmetry, the oblique shock equations and the condition that sonic speed is attained at the sharp shoulder.

From authors' summary

6186. Traugott, S. C., Shock generated vorticity and sonic line slope on the surface of blunt bodies in supersonic and hypersonic flight, Martin Co., Baltimore, RR-14, 34 pp., Feb. 1959.

The inviscid surface vorticity for axisymmetric bodies of arbitrary shape due to a detached, curved shock is obtained in terms of the shock vertex curvature. Conditions for which the slope of the sonic line is perpendicular to the surface are determined by use of this vorticity, both for a perfect gas and for a real gas. These conditions depend both on flight Mach number and body geometry. Real gas effects on the surface vorticity and sonic line slope are qualitatively discussed.

From author's summary

6187. Truckenbrodt, E., The aerodynamics of bodies in compressible flow (in German), *Z. Flugwiss.* **6,** 1, 15–20, Jan. 1958.

In the same manner as in the wing theory, the rule of Glauert and Prandtl is applied when a compressive fluid meets an axially symmetrical body. The flow corresponding to $M = 0$ has been adopted as the incompressible comparison flow at subsonic

speeds, and at supersonic speeds, the flow corresponding to $M = \sqrt{2}$. In calculating the speed distribution, the singularity method is applied, considering separately the finite thickness (displacement problem) of the body and lift. The first and second approximation of the pressure distribution given by the singularity method are compared with some typical exact solutions or with earlier-presented results of the linear characteristics method.

E. Niskanen, Finland

6188. Dryden, H. L., Some aspects of boundary-layer flow in subsonic and supersonic air streams, Proc. Third U. S. Nat. Congr. Appl. Mech., June 1958; Amer. Soc. Mech. Engrs., 1958, 19–28.

A survey of some current views and developments in boundary-layer theory is presented. Similarities between boundary-layer behavior for subsonic and supersonic flow are described. The review includes a general discussion of: compressible and incompressible laminar boundary layers, the excitation of oscillations in laminar boundary layers, transition from laminar to turbulent boundary layers, incompressible turbulent boundary layers; and turbulent boundary layers in supersonic flow. Writer stresses importance of measuring free-stream turbulence in experimental boundary-layer studies.

Reviewer believes article to be a useful survey for those interested in gaining a quick view of some aspects of boundary-layer theory.

E. Sunderland, USA

6189. Agosta, V. D., A theoretical investigation on the use of combustion products for the simulation of hypersonic flow, WADC TN 59-81 (Polyt. Inst. Brooklyn, Dept. Aero. Engng. Appl. Mech.; ASTIA AD 211 916), 23 pp., Mar. 1959.

A theoretical investigation has been performed on the use of combustion products for the simulation of hypersonic flow. Condensation limits were determined in order to insure vapor-free flow for various fuel-air combinations. For a particular case investigated (C/O = 0.32; H/O = 0; N/O = 2.57; p_t = 1200 psia; T_t = 3000 R) the ratios of pressures, specific heats, Mach number and Reynolds number closely simulate Mach 7 flight at 100,000-ft altitude in the atmosphere. The influence of scale on pressure distributions and forces, and the influence of viscous effects can be investigated using combustion gases. In addition, the cost of equipment employing this technique would be expected to be relatively low.

From author's summary

6190. Zakkay, V., and Visich, M., Jr., Experimental pressure distributions on conical elliptical bodies at M_∞ = 3.09 and 6.0, AFOSR TN 59-10 (Polyt. Inst. Brooklyn, Dept. Aero. Engng. Appl. Mech. Rep. 467; ASTIA AD 208 591), 31 pp., Mar. 1959.

Pressure distributions over two elliptical cones having a 16.7° equivalent circular cone, and a ratio of the major to the minor axis of a/b equal to 1.39 and 1.78 are presented for different angles of attack. A hypersonic approach similar to Newtonian is suggested for the determination of the pressure distribution. The resulting pressure distribution determined by this method compares more favorably with the experimental results than the Newtonian theory.

From authors' summary

6191. Gadd, G. E., The interaction between a weak normal shock wave and a turbulent boundary layer, *Aero. Res. Counc. Lond. Curr. Pap.* 424, 29 pp., 1959.

A simple model of flow in a straight two-dimensional channel with slightly supersonic Mach number upstream of the normal shock is analyzed. The boundary layer is treated as if it were a uniform subsonic frictionless layer. The shape of the pressure distribution at the wall and its mode of variation with upstream Mach number and channel height are predicted.

G. E. Nitzberg, USA

6192. Hakkinen, R. J., and Trilling, L., On the interaction of an oblique shock wave with a laminar boundary layer, 9th Congrès Intern. Mécan. Appl., Univ. Bruxelles, 1957; **4,** 5–14.

An experimental study of the interaction between an oblique shock wave and a laminar boundary layer along a flat plate has been made in an attempt to analyze the interaction mechanism in detail. Experiments were made in the MIT continuous 8-in. × 8-in. supersonic tunnel at a free-stream Mach number M = 2.05. The Reynolds number at shock impact location was varied over the range $1 \times 10^5 \leq Re_x \leq 6 \times 10^5$. Shock strength was varied so that overall pressure ratio was in the range $1.05 \leq \frac{P3}{P1} \leq 2.42$. Measurements included wall static pressures, skin friction, and boundary-layer velocities. With measured flow patterns suggesting a mathematical model, authors obtain, through considerations of conservation of mass and momentum in the separated flow region, a simplified interaction theory. This theory agrees satisfactorily with measured values of: (a) variation with Reynolds number of the pressure rise required to separate a laminar boundary layer; and (b) variation with Reynolds number and shock strength of the length of the separated region.

A. Ritter, USA

6193. Galin, G. Ia., Shock waves in media with arbitrary equations of state, *Soviet Phys.-Doklady* **3,** 2, 244–247, Dec. 1958. (Translation of *Doklady Akad. Nauk SSSR (N. S.)* **119,** 6, 1106–1109, Mar.–Apr. 1958 by Amer. Inst. Phys., Inc., New York, N. Y.)

Author presents theorems on the possible number of intersections between Hugoniot curves and isentropics starting from the common initial p, v point in a medium where $(\partial^2 p/\partial v^2)_s$ can change sign. Author believes this information to be essential to the problem of establishing the thermodynamic relations between equation of state and change of state through the shock wave. However, respective statements in his initial paragraph are either ambiguous or incorrect: the function $s(p, v)$ and with it the equation of state are always obtainable from the Hugoniot curves as shown by reviewer in *ASME Trans.* **80,** p. 1–10, 1958.

E. F. Lype, USA

6194. Ong, R. S., On the generalized Prandtl relation, *J. Aero. Sci.* **25,** 3, 209–210 (Readers' Forum), Mar. 1958.

The two-dimensional Prandtl relation between the normal velocities on each side of a shock wave and a critical speed of sound is here extended to a four-dimensional Euclidean space time manifold. Author's final result does not follow as suggested from his penultimate equation. Reviewer considers that the generalized relation should be

$$(\bar{n}_t + v^\lambda \bar{n}_\lambda)_1 \, (\bar{n}_t + v^\mu \bar{n}_\mu)_2 = c^2, \qquad [*]$$

where c^2 = pressure jump/density jump, v^λ are the velocity components, and $\bar{n}_j$ are the space-normalized components of the unit normal vector n_j as defined by N. Coburn [Vector and tensor analysis, p. 289, 1955].

Errors (including two noted in *J. Aero/Space Sci.* **26,** 6, p. 393, June 1959) which detract from the value of this article are (1) denominator of Eqs. [5] should be replaced by its square root, (2) c, and not c^2, is usually referred to as the "velocity of sound," (3) in the equation preceding Eq. [9] only two terms should be included in the square bracket, (4) the final equation is not in general a consequence of Eqs. [5] and [11] and should be replaced by Eq. [*] above.

S. Kirkby, England

6195. Grigorian, S. S., On exact solutions of certain gas-dynamical equations, *Soviet Phys.-Doklady* **3,** 4, 732–735, Apr. 1959. (Translation of *Doklady Akad. Nauk SSSR (N.S.)* **121,** 4, 606–609, July–Aug. 1958 by Amer. Inst. Phys., New York, N. Y.)

A class of similarity solutions for one-dimensional, nonsteady flow of a perfect gas is stated without derivation. These flows,

in which velocity, density, and pressure initially vary exponentially, may contain a shock wave which cannot be overtaken by disturbances originating within a certain region behind the shock wave. Presentation is extremely condensed so that conclusions cannot readily be verified. G. Rudinger, USA

6196. Kirchgassner, K., On the effect of slip on the development of the Taylor-Gortler vortices in a rarefied gas (in German), *Dtsch. Versuchsanstalt Luftfahrt, Ber.* 75, 29 pp., Nov. 1958.

When the Knudsen number is not very small the notion of a continuum breaks down and the conventional boundary-layer equations are no longer strictly applicable. However no satisfactory alternative has been found and the physically most acceptable theory uses these equations together with a slip boundary condition at the wall to describe the flow.

Author substitutes the velocity profile obtained in this way, but after slight modification, into the standard equations of the theory of the Taylor-Görtler vortices. Hence he is able to show, using established methods, that increasing the Knudsen number from zero is equivalent, so far as the onset of instability is concerned, to increasing the curvature of the wall.

K. Stewartson, England

6197. Glauert, M. B., A boundary-layer theorem, with applications to rotating cylinders and slip flow (in English), 9th Congrès Intern. Mécan. Appl., Univ. Bruxelles, 1957; **4**, 43–49.

A theorem is proved which allows developing a new solution to unsteady compressible three-dimensional boundary-layer problems, provided that another solution is known. Conditions at the rigid surface are changed; that permits, for example, finding the solution for moving surface when a solution for surface at rest is known. Applications to rotating cylinder and slip flows are briefly sketched. No numerical computation is presented.

G. Moretti, USA

6198. Harris, E. L., and Patterson, G. N., Properties of impact pressure probes in free molecule flow, Univ. Toronto, Inst. Aerophys. Rep. 52, 18 pp., Apr. 1958.

Granted adequate instrumentation for the measurement of very low pressures, and an application in which slow time response and outgassing of probe and gage surfaces are not serious problems, a free-molecule-flow impact pressure probe is extremely useful.

Authors analyze by kinetic theory the relation between the pressure-density product in the gage volume and that in a Maxwellian free stream, when these regions are connected by a straight, constant-bore, circular-cylinder impact probe with axis parallel to the free-stream velocity. Other assumptions are: steady state, no outgassing of internal surfaces, diffuse reflection of all molecules at internal surfaces.

While these explicit assumptions, and the basic reference to P. Clausing [*Ann. der Physik*, **5**, 12, p. 961, 1932], are just those used previously by Chambré and Schaaf in treating this same problem [*J. Aero. Sci.* **15**, 12, p. 735, 1948], the final answers obtained are very different (by about a factor of 6 in the one case checked by reviewer). Since present paper contains experimental confirmation of its own theory for long, thin tubes and Mach numbers up to 1, reviewer assumes that the previous paper by Chambré and Schaaf is in error and that the present one is to be preferred.

F. S. Sherman, USA

6199. Galkin, V. S., On a class of solutions of Grad's moment equations, *Appl. Math. Mech. (Prikl. Math. Mekh.)* **22**, 3, 532–536, 1958. (Pergamon Press, 122 E. 55th St., New York 22, N. Y.).

Author constructs a certain class of solutions of Grad's moment equations. The starting points are the well-known Grad's thirteen-moment equations in the absence of external forces of an ideal monatomic gas with Maxwellian molecules under the assumption that all the moments of the distribution function are functions of time t, and the macroscopic velocity depends linearly on the coordinates. This reduces the problem to that of solving two independent systems of 6 and 10 homogeneous linear differential equations of the first order with variable coefficients, the systems being connected by one equation. The particular cases solved are: (a) a flow with spherical propagation; (b) superposition of the uniform flow on the shear flow; (c) uniform flow which decreases with time; (d) shearing flow. This is an interesting contribution to the difficult problem of finding solutions to equations of the kinetic theory of gases.

M. Z. v. Krzywoblocki, USA

6200. Franke, W., Compressional shock in the atmosphere generated by a vertical rarefaction wave (in German), *Z. Flugwiss.* **5**, 10, 292–302, Oct. 1957.

Paper gives unsteady-flow solution of momentum, energy, and continuity equations for "one-dimensional" (horizontally homogeneous) nonviscous atmosphere with finite height (temperature decreases with height). Method of characteristics is used to construct approximate numerical solutions. Initial condition is taken as horizontally-uniform downdraft beginning at selected height and time, accelerating at constant rate for prescribed time, then proceeding without further acceleration at leading edge. Wave of rarefaction produced by motion travels upward into atmosphere, thus into region where speed of sound is less than particle velocity; shock wave of compression is generated and propagates downward. Shock is characterized by "jumps" in pressure, temperature, density, and entropy. Propagation Mach number is of order 0.1 to 0.4, and pressure jump of order 20 mm Hg in extreme example given. Author suggests that pressure jumps of this type may occur in connection with katabatic winds.

Reviewer considers mathematical treatment thorough and correct. Main question of applicability to real atmosphere concerns effect of viscosity in limiting particle velocity, thus preventing buildup of supersonic speeds and shock wave. Possibility exists that thunderstorm downdrafts are equally effective as katabatic winds in producing such jump lines.

E. W. Barrett, USA

Boundary Layer

(See also Revs. 6168, 6191, 6196, 6197, 6237, 6297)

6201. Zaat, J. A., Behavior of the three-dimensional laminar boundary layer at an increasing angle of attack (in German), *Nat. LuchtLab., Amsterdam TN* F-215, 27 pp., Sept. 1958.

Two versions of a momentum method for the three-dimensional boundary layer [AMR **11** (1958), Rev. 561] are carried out for an infinite yawed airfoil at an angle of attack. Simplified version gives very satisfactory results in many cases.

K. G. Guderley, USA

6202. Thomson, J. Y., and Mitchell, A. R., The application of finite difference methods to the solution of problems in boundary layer flow (in English), 9th Congrès Intern. Mécan. Appl., Univ. Bruxelles, 1957; **4**, 60–66.

Authors outline a finite difference scheme for obtaining solutions of the laminar boundary-layer equations set in the von Mises variables. This technique is checked out on the case of incompressible laminar boundary-layer flow with a prescribed pressure gradient. Calculations are currently in progress for the compressible case in order to demonstrate the effect on the general solution of the assumptions of unit Prandtl number and a linear viscosity-temperature relation. A. Ritter, USA

6203. Ananda Murthy, K. R., and Hammitt, A. G., Investigation of the interaction of a turbulent boundary layer with Prandtl-Meyer expansion fans at M = 1.88, AFOSR TN 58-839, (Princeton Univ.,

Dept. Aero. Engng. Rep. 434; ASTIA AD 203 081), 35 pp., Aug. 1958.

An investigation has been made to study in detail the interaction of expansion fans with a two-dimensional supersonic turbulent boundary layer at a free-stream Mach number of 1.88. The angle of expansion, which is the only parameter varied in this experimental set up, varies from 5° to 30°. Schlieren photographs of the flow pattern have been taken to obtain an overall picture of this type of interaction. Static pressure and total head tube measurements have been made to study the interaction in detail. The method of rotational characteristics has been applied to the boundary-layer velocity distribution as it expands around the corner to construct the flow field and to calculate the inviscid pressure distribution near the corner as a better approach to the problem than the classical Prandtl-Meyer flow.

The turning of the supersonic flow around a sha p corner causes the flow to accelerate, giving rise to a lower static pressure. In the absence of a boundary layer, the flow field obtained after the expansion should correspond to the classical Prandtl-Meyer flow around a corner. Due to the presence of a boundary layer, the flow field is modified and does not agree with the classical flow near the corner, but it approximates Prandtl-Meyer flow some distance downstream from the corner. The pressure near the corner is quite high and differs from the discontinuous pressure drop at the corner predicted for the classical Prandtl-Meyer flow. The initial pressure behind the corner is related to the expansion of the lower velocity layers near the surface.

For the larger angles of expansion, a new thin boundary layer seems to start from the corner. Total head surveys made for the 25° expansion case indicate that a high shear layer exists near the wall which appears to start from the corner. Downstream of the corner the original boundary layer tends to merge with the free stream. From authors' summary

6204. Favre, A., Gaviglio, J., and Dumas, R., Turbulent boundary layer: space-time correlations and velocity spectra (in French), *ONERA Publ.* 92, 107 pp., 1958.

Continuation of authors' series of hot-wire measurements [AMR **3** (1950), Rev. 2738; **7** (1954), Revs. 281, 3966; **8** (1955), Revs. 3135, 3136; **9** (1956), Revs. 223, 3315; **11** (1958), Revs. 2260, 5093 and other papers]. Extensive measurements of streamwise turbulence component in flat plate boundary layer furnish surfaces of constant space-time correlation for optimum time delay showing path and influence of large eddies. Surfaces are banana-shaped, convexity toward wall decreasing with increasing height of reference point. Spectra show that percentage energy in low frequencies decreases roughly pro rata with increasing U/u_{max}; spectra at $y/\delta > 1$ imply longitudinal waves of length about 5δ. Results should be of assistance in formulating and testing theories of turbulence. P. Bradshaw, England

6205. Favre, A., Gaviglio, J., and Dumas, R., Space-time correlations and energy spectra in the turbulent boundary layer (in French), 9th Congrès Intern. Mécan. Appl., Univ. Bruxelles, 1957; **4**, 213–233.

Paper reviews results on measurements of space-time correlations of the axial turbulence velocity component across a boundary layer with zero pressure-gradient. It includes results already published in a number of earlier papers.

Main results are:

(a) Taylor's hypothesis $\partial/\partial t \approx -\overline{U}\,\partial/\partial x$ appears applicable, except in a region within 0.06 δ distance to the wall.

(b) The energy spectrum decreases in the lower wave number region as the distance to the wall increases, mainly due to the increased mean velocity.

(c) Space-time iso-correlation surfaces show a marked elongation in the main flow direction, even in regions close to the wall (0.03δ); the lateral dimensions are almost equal.

J. O. Hinze, Holland

6206. Culick, F. E. C., Turbulent diffusion boundary layer, AFOSR TN 58-336 (Mass. Inst. Tech., Naval Supersonic Lab. TR 279; ASTIA AD 154 240), 46 pp., Apr. 1958.

A two-region model of the turbulent boundary layer forms the basis for an analysis of equilibrium temperatures and heat transfer when helium injection is used as a method of cooling at high speeds. The fluid properties entering through the Prandtl number, Schmidt number and Lewis number are assumed to vary only with concentration. It is found that both equilibrium temperatures and heat transfer are reduced for all injection rates, and that the reduction in skin friction due to injection should be relatively greater than that for laminar flow. Final quantitative results will require a knowledge of the variation of skin friction and velocity at the sublayer edge with injection.

From author's summary

6207. Dorfman, L. A., Thermal boundary layer on a rotating disc, *Soviet Phys.-Doklady* **3**, 2, 248–251, Dec. 1958. (Translation of *Dokladl Akad. Nauk SSSR* (*N. S.*) **119**, 6, 1110–1112, Mar.–Apr. 1958 by Amer. Inst. Phys., Inc., New York, N. Y.)

Thermal boundary layers for laminar and turbulent flows on rotating disks are treated by noting the similarity in mathematical structure between the differential equation for the angular velocity component and the differential equation for the temperature. The usual relation between the frictional stress and heat flow is assumed to hold and is evaluated for laminar and turbulent flows; similar treatments for the laminar and turbulent disk flows and for the slight generalization of the axially symmetric jet impinging on a rotating disk have been given in the past by Tifford and Chu, Truckenbrodt, and Dorfman himself. The case of n-th power temperature distributions on the disk is also treated by using a momentum method due to Loitsianskii. A comparison with the exact solution for laminar flow for $n = 2$ which is due to Millsaps and Pohlhausen shows that the approximate method of Dorfman tends to overestimate the heat transfer by a slight amount in this case. The general treatment is a valuable contribution to the literature on the highly specialized problem.

K. Millsaps, USA

6208. Hegarty, J. C., Investigation of transition caused by the stopping of a flat plate, AFOSR TN 58 627 (Univ. Maryland, Inst. Fluid Dynamics Appl. Math. TN BN-141; ASTIA AD 162 157), 38 pp., June 1958.

First part of the paper presents the well-known theory of small disturbances as a solution to the Orr-Somerfeld equation. The velocity profile on the plate after the stopping is determined by superposing two Rayleigh profiles associated with two plates started impulsively from rest at different times and in opposite directions. This resultant profile is theoretically unstable and the Reynolds number based upon the displacement thickness decreases rapidly with time. Accordingly the Reynolds number employed in the experimental results is based upon the Blasius profile.

Second part of the paper concerns experimental studies on the three-dimensional character of the transition. A flow visualization past a flat plate moving in a water tank is obtained with the aid of a dye pattern. Author's original contribution consists in the realization of the "natural transition" by the plate stopping, without using a trip wire as a means to promote "artificial transition." The general conclusion is that the use of a trip wire does not modify the essential character of the transition, which consists in the forming of discrete vortex lines and in their subsequent distortion into a three-dimensional pattern. Relations

are given between the parameters $\alpha\delta^*$ (where $2\pi/\alpha$ = wave length), c_r (wave velocity) and $R\delta^*$ (Reynolds number whose values are within 500 and 1000).

S. Savulescu, Roumania

6209. Guman, W. J., On the plateau and peak pressure of regions of pure laminar and fully turbulent separation in two-dimensional supersonic flow, *J. Aero/Space Sci.* **26,** 1, p. 56 (Readers' Forum), Jan. 1959.

6210. Warner, C. F., and Reese, B. A., Investigation of the factors affecting the attachment of a liquid film to a solid surface, *Jet Propulsion* **27,** 8, Pt. 1, 877–881, Aug. 1957.

One method of establishing a protective liquid film between a flowing gas and the walls of the flow passage is by the injection of the liquid through a slot in the passage walls. The effects of liquid injection velocity, gas velocity, slot geometry, liquid physical properties and gas density upon the film attachment are examined experimentally. A correlating equation based upon momentum exchange for the case of radial injection is presented.

From authors' summary

6211. Potter, O. E., Chemical reaction in the laminar boundary layer—instantaneous reaction, *Trans. Instn. Chem. Engrs.* **36,** 6, 415–421, Dec. 1958.

In absorption and extraction processes, the rate of transfer of mass is determined by the concentration gradients and diffusion coefficients. The combined effects are described by a mass transfer coefficient often also known as the "true" mass transfer coefficient. If mass transfer is accompanied by chemical reaction, the effect of the reaction is to increase the concentration gradients and hence the rate of mass transfer. Such systems have been analyzed previously by Hatta, Danchwerts, and Sherwood and Pigford for conditions of rest or uniform motion.

In this paper the additional effect of nonuniform flow in a viscous boundary layer is considered. It is found that under boundary-layer conditions the ratio of the apparent and true mass transfer coefficients may be larger or smaller than the ratios obtained previously, depending on whether $D_A/D_B > 1$ or < 1, respectively (D_A and D_B are diffusion coefficients for species A (wall) and B (stream), respectively). For some cases considered, the changes are of the order of 20% and are significant. This additional effect is due to the effect of nonuniform flow on the concentration gradient. In the present treatment, the effects of the transfer of mass and the heat of reaction on the velocity distribution in the boundary layer were neglected.

Y.-H. Pao, USA

6212. Clarke, J. F., The flow of chemically reacting gas mixtures, *Coll. Aero., Cranfield Rep.* 117, 28 pp., Nov. 1958.

Author derives and discusses various forms of the equations for flow in an inviscid, non-heat-conducting gas in which chemical reactions are occurring. Application is made to the speeds of sound with special attention given to the difference between frozen and equilibrium sound speed. Using Lighthill's [*J. Fluid. Mech.* **2,** 1, 1–32, Jan. 1957; AMR **12** (1959), Rev. 2568] ideal dissociating gas the phenomenon of sound absorption and dispersion are explained as attributes of a chemically reacting gas mixture.

Author is commended for presenting a lucid exposition of several concepts that appear with increasing frequency in the literature. Such things as relaxation time, frozen flow, equilibrium flow, entropy change in reacting flows, frozen and equilibrium sound speeds, and sound propagation in an ideal dissociating gas are treated with insight and clarity.

Discussion of the flow velocity at a nozzle throat is used to effectively support Broer's [*J. Fluid Mech.* **4,** 3, 276–282, July 1958; AMR **12** (1959), Rev. 1401] comments on Resler's [*J. Aero. Sci.* **24,** p. 785, 1957; AMR **11** (1958), Rev. 2365] theory of characteristic directions in a reacting gas.

Most interesting feature of this paper, in reviewer's opinion, is the detailed treatment of sound propagation in an ideal dissociating gas. Small disturbance theory is used to derive the pertinent equations. These clearly show the differences between frozen and equilibrium sound propagation and the several relaxation effects that are important.

Reviewer believes this paper to be primarily of a review nature but so well written as to deserve close attention from interested readers.

A. Kovitz, USA

6213. Betchov, R., Simplified analysis of boundary-layer oscillations, Douglas Aircr. Co. Rep. ES-29174, 84 pp., Mar. 1959.

The stability of an incompressible boundary layer is analyzed in terms of three basic processes. These are (1) the oscillations of a boundary layer when friction is disregarded, (2) the effects of friction at the wall, and (3) the effects of friction at the critical layer. These processes are separately discussed and evaluated. Simple models are presented.

From author's summary

6214. Tani, I., An example of unsteady laminar boundary layer flow, *Univ. Tokyo, Aero. Res. Inst. Rep.* 331, 12 pp., June 1958.

The flow velocity outside the boundary layer is considered to be of the form $U = V - x\phi(t)$, where V is a constant velocity and $\phi = 1/(T - t)$ (t being the time and T a constant time). Thus an extension is obtained of the solution given by Howarth for the case ϕ = const [*Proc. Roy. Soc. Lond.* (*A*) **919,** 164, p. 547, 1938]. After introducing the dimensionless variables $\xi = 8x/V(T - t)$ and $\eta = y/2(V/\nu x)^{\frac{1}{2}}$ (y being the distance normal to the wall and ν the kinematic viscosity), which resemble those used by Howarth, author develops the stream function into a power series in ξ whose coefficients are function of η. After replacing in the momentum equation he obtains a system of differential equations for the coefficient functions. The integration is performed numerically, the method being described in the appendix and the results listed in a table. As the series converges slowly, the six calculated coefficients are not sufficient for determining the point of separation and therefore author uses the method of continuation indicated by Howarth. Besides the position of the separation point, the displacement thickness, the momentum thickness and the wall velocity gradient are calculated.

As a practical application the case of plane flow in a divergent channel with moving walls is treated.

T. D. Oroveanu, Roumania

Turbulence

(See also Revs. 6149, 6171, 6203, 6204, 6205, 6209, 6370)

6215. Kovalev, A. A., On Chandrasekhar's spectral representation of axially symmetric turbulences, *Soviet Phys.-Doklady* **3,** 3, 510–513, Jan. 1959. (Translation of *Doklady Akad. Nauk SSSR* (*N. S.*) **120,** 6, 1220–1223, May–June 1958 by Amer. Inst. Phys., Inc., New York, N. Y.)

Author considers a spectral representation of axially symmetric turbulence of Chandrasekhar's type. The origin of axially symmetric turbulence connected with the presence in the system of a direction which is singled out physically is referred to a temperature field (a constant mean temperature gradient along the vertical). The starting points are the usual equations of an incompressible turbulent motion (including energy) and the correlation functions (to the approximation in which the effect of the third correlation moments is neglected). By means of the usual technique the forms of the most characteristic correlation functions are found: velocity, velocity-temperature correlation functions, etc., as well as the equations governing the behavior of these func-

tions. The resulting system consists of four scalar partial differential equations; the general solution of this system is assumed in the form of series containing exponential terms. The exponential power coefficients are the roots (four in number) of the characteristic equation, and the arbitrary functions appearing in the series are determined by the initial values of the correlation functions. As a particular case the author calculates the functions in the last stage of degeneration of turbulence and as a by-product the scattering of sound in an axially symmetric turbulent flow.

M. Z. v. Krzywoblocki, USA

6216. Filippov, G. V., On turbulent flow in the entrance length of a straight tube of circular cross section, *Soviet Phys.-Tech. Phys.* **3,** 8, 1681–1686, Mar. 1959. (Translation of *Zh. Tekh. Fiz., Akad. Nauk SSSR* **28,** 8, 1823–1829, Aug. 1958 by Amer. Inst. Phys., Inc., New York, N. Y.)

The turbulent flow in the entrance length of a tube of circular cross section has been calculated by Latzko [*ZAMM* **1,** 268–290, 1921] using the momentum equation and the "one-seventh power law" for the velocity distribution. Here an improved solution of this problem is given, also using the momentum equation but the logarithmic law for the velocity distribution. The result of the rather tedious calculations has been summarized in the following simple formula for the entrance length $L_e : L_e/d = 2.44/\sqrt{\lambda}$, with d being the diameter and λ the resistance coefficient of the stabilized flow. This formula is claimed to be in better agreement with measurements than that of Latzko.

H. T. Schlichting, Germany

6217. Barrow, H., The eddy diffusivity in annular flow, *J. Roy. Aero. Soc.* **63,** 579, 180–181 (Tech. Note), Mar. 1959.

6218. Haberstich, A., and Hama, F. R., A correlation analyzer, AFOSR TN-58-338 (Inst. Fluid Dynam. Appl. Math., Univ. Maryland, TN BN-125; ASTIA AD 154-242), 54 pp., Mar. 1958.

Aerodynamics

(See also Revs. 5870, 5871, 6182, 6199, 6264, 6266, 6267, 6294, 6345, 6348)

Book—6219. Arshanikow, N. S., and Malzew, W. N., Aerodynamics [Aerodynamik] (Translated to the German from Russian), Berlin, VEB Verlag Technik, 1959, 496 pp. DM 38.

Book is basically an analytical treatment of fluid dynamics and gas dynamics for engineers concerned with research or with development of fluid flow machinery. The mathematical level is that of a good engineering student after his senior year; the explanations are concise, clear and complete, and relate the analysis to physical facts. No problems are included but some (very few) practical examples are worked out as applications of the theory. The graphs are sufficient in number, clear and simple, although occasionally not too accurate (e.g., spacing of stream lines for flow about the circular cylinder). Paper, printing, and proofreading are excellent, so are the organization of the book and equations, the index, and the list of names representing a valuable source of references for important Russian contributions. Many Russian names which are hardly known in other countries appear as references. The uninformed reader may gain the impression from the *main* text that Russian authors made most contributions, followed by German authors, and that other nations contributed little to the special literature. A typical sentence is: "Soviet aerodynamicists solved this problem successfully and completely ...(The problems of ...were treated in Germany by ...)." The *historical* survey, however, gives an unbiased and very good account of names of all nationalities in Chapter 1.

The publisher of the translation (of the second edition) states in the preface that the latest results of theoretical and experimental aerodynamics have been used; however, unsteady, transonic, hypersonic, free-molecule flow are not treated and "latest results" should include these topics. Reviewer would like to see, e.g., more than one page devoted to the method of Lagrange, a derivation of the stability of the Kármán vortex street, more discussion of sweep; on the other hand, the derivation of forces and moments in the Joukowski transformation, of the shape of the laminar boundary layers for flat and curved surfaces, of improved methods for the distribution of circulation, etc., and a table of lift coefficients for various planforms in supersonic flow are definite assets which are not found elsewhere in one book but must be looked up in dispersed reports.

The first eleven chapters deal with kinematics of fluids, stream functions and velocity potentials, vortex theory, complex potentials, transformations, viscous flow and boundary layer, induced effects; the last seven chapters with gas dynamics, isentropic flow, two-dimensional supersonic flow (shock-expansion) including the hodograph and characteristics methods, subsonic compressible and linearized supersonic flow.

In summary, the book is excellent in its arrangement and comprehensiveness of the mathematical treatment of the topics just listed and in its accuracy but, except for valuable references, does not offer new material.

G. R. Graetzer, USA

Book—6220. Payne, P. R., Helicopter dynamics and aerodynamics, New York, The Macmillan Co., 1959, xiii + 442 pp. $17.

This book is an excellent introduction to the fundamentals of helicopter design. It does not attempt to cover fixed wing and elementary helicopter dynamics and the reader is assumed to be familiar with the work of Gessow and Myers. The only shortcomings of the text are the cursory treatment of blade flexibility and downwash predictions. Author continually emphasizes practical aspects of all phases of helicopter design, and sound engineering judgment rather than complete dependence on theory guides the choice of the working equations. The chapter headings serve as a good guide to the scope of the text. The chapter headings are 1. General aerodynamics; 2. Induced aerodynamics; 3. Fundamentals of rotor dynamics; 4. Dynamics of rotors with hinge constraint; 5. Flapping stability and blade movements in gusts; 6. Performance; 7. Stability and control; 8. Rotor vibration; 9. Ground resonance and vibration due to rotor resonance; 10. Control loads and vibration; 11. Blade flutter and rotor weaving; 12. Blade flexing and resonance.

W. S. Aiken, Jr., USA

6221. Graham, E. W., A geometric problem related to the optimum distribution of lift on a planar wing in supersonic flow, *J. Aero/Space Sci.* **25,** 12, 771–774, 778, Dec. 1958.

Paper considers problem of obtaining lift distribution from the integrated values of lift along lines crossing the wing planform. According to author, solution to the problem has previously been given by Radon. No specific examples are presented.

Reviewer believes paper would have more value if the presentation had been clearer and examples had been included.

W. L. Haberman, USA

6222. Roshko, A., Pressure distribution at the nose of a thin lifting airfoil, Douglas Aircr. Co. Rep. SM-23368, 27 pp., Nov. 1958.

Simple expressions for the pressure distribution at the nose of a lifting, symmetrical airfoil are obtained by comparison with a simpler "airfoil" consisting of an ellipse with a fin. These compare favorably with measurements and exact calculations of pressure distributions on several thin airfoils.

From author's summary

6223. Ting, L., Pressure distribution on dihedral wings at supersonic speed, Polyt. Inst. Brooklyn, Aero. Lab. Rep. no. 397, 46 pp. + 14 figs., Jan. 1958.

Two averaging properties of solutions of the wave equation associated with the boundary and the initial data, respectively, are proved by using Green's theorem: (I) For the problem of linearized supersonic flow over dihedral wings with prescribed normal velocity on the two planes of the wings, the product of the dihedral angle and the pressure along the line of intersection of the planes of the wings is independent of the dihedral angle and is, therefore, equal to π times the corresponding pressure for planar wings, (II) For the problem of diffraction of an arbitrary two-dimensional incident pulse by a wedge of angle μ the resultant disturbance pressure at the corner at any instant is equal to $2\pi/(2\pi - \mu)$ times the value of the incident pulse.

By virtue of these results the pressure distribution in supersonic flow along the line of intersection of the two halves of a wing with supersonic edges, with dihedral (and with arbitrary twist, camber and thickness distribution assumed to be sufficiently small to permit linearization), is obtained from the corresponding solution for planar wings. By a linear integral relationship, given earlier by the author [Pibal Rep. 379, Apr. 1957; AMR **11** (1958), Rev. 1290], the integral of the pressure along the line of intersection of a Mach plane with the wing surface can be obtained from the integral of the prescribed normal velocity. Pressure distribution on the wing can, thus, be represented by a function of two variables which assumes the proper values along the Mach lines issuing from the wing vortex and along the line of intersection of the wing halves. Integral relationships corresponding to Mach planes at various orientations provide further information on this function. Assuming then, for instance, the pressure distribution to be represented by linear superposition of a certain number of given functions including a certain number of constants, these constants can be determined by using an appropriate number of properly chosen Mach planes and their corresponding integral relationships. This idea is worked out using polynomials of low degree (correcting, eventually, by adding the proper root singularity for pressure distribution near the Mach cone) in the case of constant normal velocity on the surface of the dihedral wings (a conical problem) and perfect agreement is obtained by using two arbitrary constants and two integral relationships only. When the normal velocity on the wing surface can be represented by a power series of two variables, the general procedure of obtaining an approximate solution is outlined and illustrated by an example. Finally, for a partially twisted and partially sweptback wing with dihedral the detail pressure distribution on the wing is worked out.

The same procedure can be applied to the problem of diffraction by wedges or corners and also the problem of interference of wings and prismatic bodies at supersonic speed.

H. Behrbohm, Sweden

6224. van Spiegel, E., and Timman, R., Linearized aerodynamic theory for wings of circular planform in steady and unsteady incompressible flow (in English), 9th Congrès Intern. Mécan. Appl., Univ. Bruxelles 1957; **2,** 393–403.

Paper summarizes the extensive work of the authors on steady and unsteady motion of a thin lifting surface of circular planform in incompressible flow (more detail will be found in Rept. F189, Nat. Aero. Res. Inst., Amsterdam, 1956, and an unpublished doctoral thesis, "Boundary-value problems in lifting surface theory," Delft, 1959, both by the senior author). By separation of the governing Laplace equation in oblate spheroidal coordinates, regular solutions for the velocity potential and acceleration potential are constructed in terms of a Green's function of the second kind. Comparison of these two expressions and careful examination of the normal acceleration of fluid particles near the wing leading edge suggest a technique for constructing singular solutions. The complete solution of the physical problem, including Kutta's trailing-edge condition, is then developed from the regular acceleration potential and an incremental solution which is singular only along the leading edge. An unknown weighting function in the latter is calculated from the condition of flow-tangency at the wing surface; this process yields an integral equation which can be replaced by a system of linear algebraic equations. Good convergence is obtained during the inversion of the latter after truncation. Numerical examples for plane and parabolically cambered surfaces agree with earlier results obtained by less refined approaches to the same problem, except for one which the authors identify as incorrect.

H. Ashley, USA

6225. Moiseev, N. N., and Ter-Krikorov, A. M., Concerning the nonsingularity of the solution of the submerged airfoil problem, *Soviet Phys.-Doklady* **3,** 2, 240–243, Dec. 1958. (Translation of *Dokladi Akad. Nauk SSSR (N. S.)* **119,** 5, 899–901, Mar.–Apr. 1958 by Amer. Inst. Phys., Inc., New York, N. Y.)

A submerged airfoil problem is treated by the nonlinear theory. Approximate solutions are obtained for the Froude number both smaller and larger than unity. The solutions are then studied in the limiting case when the Froude number approaches unity. The nonsingularity of the solution obtained by the nonlinear theory is shown. An example of a motion of a vortex beneath the fluid surface is discussed.

C. P. Kentzer, USA

6226. Ting, L., Favorable interference of a body and biplane combination in supersonic flow, AFOSR TN 59-200 (Polyt. Inst. Brooklyn, Dept. Aero. Engng. Appl. Mech. Rep. 510; ASTIA AD 211 526), 10 pp., Mar. 1959.

An optimum contoured prismatic body mounted on a triangular midwing is compared with the combination of the same body with a biplane arrangement of a triangular high wing and low wing. For the same lifting surface, the span of the wings of the second combination is one-half of that of the midwing. Therefore the second configuration is definitely favorable from a structural point of view. It is also favorable from the aerodynamics point of view as explained in the present report. For the special configurations considered in the numerical example, a reduction with the biplane yields more reduction in drag due to lift than that with the monoplane.

From author's summary

6227. Rubin, E. S., and Kerwin, E. M., Jr., Experiments in unsteady aerodynamics leading to the development of an acoustic drag coefficient (in English), 9th Congrès Intern. Mécan. Appl., Univ. Bruxelles, 1957; **4,** 373–386.

Authors have studied the unsteady shock oscillation ahead of a bluff body with protruding spike in a supersonic stream. A 4½-in. diameter square-fronted cylinder with spike lengths 5.5-in. to 14-in. was tested at $M = 4.3$, and oscillating, steady and unstable régimes were observed.

The present paper deals with one aspect of this work—the relation between aerodynamic drag and sound intensity. A theoretical study was prompted by the experimental finding that increase in drag coefficient under oscillating conditions correlates well with sound intensity.

The theoretical analysis considers one-dimensional oscillation of the normal shock and calculates the total acoustic power radiated by virtue of its oscillation. An acoustic drag coefficient is then defined as the ratio of radiated acoustic power to drag power. For the experimental values given the acoustic drag coefficient is 0.525, which compares with an increase in aerodynamic drag coefficient of 0.7 (from 0.3 to 1.0) during transition from steady to oscillating flow.

Although some aspects of the analysis are open to question, the concept of an acoustic drag coefficient to explain drag increase during oscillation appears quite useful.

D. G. Stewart, Australia

6228. Jacobs, W., New theoretical investigations on jet wings in two-dimensional flow (in German), *Z. Flugwiss.* **5**, 9, 253–259, Sept. 1957.

Two-dimensional theory of a flat plate with jet-flap. The jet is replaced by a flap the lift of which equals the vertical component of the jet reaction force. Theory is given (1) for a straight flap and (2) for a curved flap of the form $\eta = \eta_0 \exp(-K(x - x_0)/x_0 c_j)$, where K is constant (near 1) and c_j is a dimensionless jet coefficient. Using the results of Glauert's flap theory, lift and moment are calculated in dependence of c_j and η_0 (flap deflection). Results are compared with measurements by Dimmock (1956). This comparison shows a better agreement with the experiment for the curved flap theory than it does for the straight flap assumption, especially for pitching moment.

F. W. Riegels, Germany

6229. Taylor, A. S., The present status of aircraft stability problems in the aeroelastic domain, *J. Roy. Aero. Soc.* **63**, 580, 227–238, Apr. 1959.

A clear and compact theoretical background is given of the recent developments in the study of the effects of structural flexibility on the stability and control of aircraft; the discussions are confined mainly to the dynamic longitudinal stability. It is illustrated how, starting from the semirigid equations of motions the following items can be dealt with: short period response of rigid and flexible aircraft, steady maneuvering flight, static margin, control reversal and divergence, transfer functions. It is shown how reasonably accurate results can be obtained from an integrated approach to the aeroelastic problem in general by applying a number of simplifying assumptions for a special problem.

Several reports on both theoretical and experimental investigations in this field are reviewed. J. Buhrman, Holland

6230. Heins, W., and Lehnigk, S., An investigation of the dynamic longitudinal stability of an airplane by means of the root-locus method (in German), *Z. Flugwiss.* **6**, 11, 309–314, Nov. 1958.

The root-locus method for vibration problems is reviewed briefly, with references to Evans [*Trans. AIEE* **69**, 66–69, 1950], and Yeh [*Trans. ASME* **76**, 349–361, 1954; AMR **7** (1954), Rev. 2748]. It is then pointed out that the (quartic) characteristic equation of small oscillations of an airplane is suited to this procedure. As an example, the longitudinal oscillations of a certain glider are considered. First, the rectangular area of possible center-of-gravity positions r and flying speeds V in an r, V plane are specified. The root-locus method is then applied for each of the four sides of this rectangle, giving four curves of frequency versus damping for the glider. This diagram is constructed for both the speed and angle-of-attack oscillations, and various conclusions are drawn. W. R. Sears, USA

6231. Bazzocchi, E., An analytical study of spin on the basis of tests in a horizontal wind-tunnel—a method of testing models in free air (in Italian), *Aerotecnica* **37**, 4, 178–200, Aug. 1957.

6232. Bullen, N. I., The distribution of gusts in the atmosphere. An integration of U. K. and U. S. data, *Aero. Res. Counc. Lond. Curr. Pap.* 419, 19 pp., 1959.

Information on gust frequencies in the British papers is derived from counting accelerometer records, and in the U.S. from the V.g.h. recorder. The methods of deriving the gust velocity from aircraft acceleration are first compared. The relative frequencies of gusts of differing magnitudes are then examined, and, finally, the absolute frequencies at varying heights are compared. In general there is good agreement between the two sets of data.

From author's summary

6233. Etkin, B., A theory of the response of airplanes to random atmospheric turbulence, Univ. Toronto, Inst. Aerophys. Rep. 54, 50 pp., May 1958.

Paper contains a significant contribution to the analytic treatment of airplane responses to two-dimensional random atmospheric turbulence. The turbulence field in the neighborhood of the airplane is approximated by a two-dimensional series expansion consisting of the superposition of several relatively simple spacial distributions, each varying with frequency. This representation yields a good approximation to the exact turbulence and downwash fields and has the advantage of effectively reducing the two-dimensional disturbance response problem to a combination of simple one-dimensional disturbance response problems. The forces and moments arising from the components of the downwash field are expressed in terms of a set of aerodynamic derivatives such as are used in stability and flutter analysis. The application of this formulation to the lateral and longitudinal equations of motions is discussed briefly.

The results given should find useful applications in the study of the effects of spanwise variations in the turbulence field.

H. Press, USA

Vibration and Wave Motion in Fluids

(See also Rev. 6063)

Book—6234. Rundgren, L., Water wave forces, a theoretical and laboratory study, Stockholm, Elanders Boktryckeri Aktiebolag, 1958, 123 pp.

See AMR **11** (1958), Rev. 3633.

6235. Phillips, O. M., The scattering of gravity waves by turbulence, *J. Fluid Mech.* **5**, 2, 177–192, Feb. 1959.

A theory is developed to describe the properties of waves on the free surface of a liquid in turbulent motion. The distinction between the interacting wave and turbulent motions is achieved by separating the velocity field uniquely into a surface-induced contribution characteristic of the wave motion and a vorticity-induced contribution associated with the turbulence. The theory is applied to the scattering of gravity waves passing over the surface of deep water which has a turbulent motion of sufficiently low mean square vorticity. Expressions are derived for the directional distribution of the scattered wave and for the logarithmic decrement resulting from the scattering. It is shown that, under typical conditions in open sea, the attenuation from scattering will be greater than that from direct viscous dissipation for wavelengths greater than about 3 m.

From author's summary by H. J. Schoemaker, Holland

6236. Francis, J. R. D., Wind action on a water surface, *Proc. Instn. Civ. Engrs.* **12**, 197–216, Feb. 1959.

6237. Lhermitte, P., A contribution to the study of the boundary layer of monochromatic water waves (in French), *Houille Blanche* **13**, A, 366–376, July 1958.

This is a study of the boundary layer at the bottom of a horizontal channel containing fluid in wave motion. By defining the boundary-layer thickness as a function of time and horizontal distance, author is able to obtain a solution of the boundary-layer equation (in this case the heat-conduction equation) satisfying the boundary conditions at the solid boundary and at the edge of the boundary layer. Observations with the aid of dye support the qualitative features of this solution. Instability of the boundary layer is also observed, and a discussion of stability in general terms is presented.

From the form of the solution, the boundary-layer thickness is not purely periodic with respect to time. (If it were, one would wonder why the vorticity in the boundary layer does not diffuse into the main body of the fluid.) How long will it take before rotationality will occupy the entire fluid and thus the fundamental assumption on which the solution is based be violated? This point, as well as the free-surface boundary layer, has not been discussed. Nevertheless, the paper is interesting.

C.-S. Yih, USA

6238. Puzanov, A., The solution of the motion of open-channel surges (in English), *Rozpravy Československé Akad. Věd* **65,** 6, 67-74, 1955.

6239. Daubert, A., A third-order approximation of complex waves (in French), *Houille Blanche* **13,** A, 358-363, July 1958.

The Lagrangian description is adopted to study surface waves of an inviscid fluid in a horizontal channel. The wave motion is not supposed to be irrotational, or periodic spatially or temporally. The vorticity is assumed only to be a function of the Lagrangian coordinate y_0. The equation of continuity and the equation expressing the persistence of vorticity, both in Lagrangian coordinates, are then solved to the third order (in the amplitudes of the pure-waves constituting the first approximation to the complex wave). The results are given only in general terms, since no particular assumption has been made on the variation of vorticity with y_0. These results are pertinent to mass transport by wave motion.

C.-S. Yih, USA

6240. Hahne, H. V., Oscillations of a gas in an elastic cylindrical shell, Proc. Third U. S. Nat. Congr. Appl. Mech., June 1958; Amer. Soc. Mech. Engrs., 1958, 753-760.

Theory of standing waves of a gas contained in a cylindrical tube with elastic walls. End effects are not considered. The frequency equation for the general case is deduced. This equation is discussed in detail for longitudinal modes (i.e. modes independent of the angular coordinate) and circumferential modes (independent of the axial coordinate). Numerical results for the latter case are presented.

L. J. F. Broer, Holland

6241. Galin, G. Ia., On the propagation of disturbances in media having a nonlinear dependence of the stresses on the strains and temperature, *Soviet Phys.-Doklady* **3,** 3, 503-506, Jan. 1959. (Translation of *Doklady Akad. Nauk SSSR (N. S.)* **120,** 4, 730-733, May-June 1958 by Amer. Inst. Phys., Inc., New York, N. Y.)

This paper considers one-dimensional wave motions, e.g., through a semi-infinite half-space of compressible gas, or along a semi-infinite rod. Initially the medium is motionless and under uniform pressure (stress). Then one face (end) is raised instantaneously to a higher pressure (stress) and maintained thus. It is shown how the equation of state (stress versus strain and internal energy relationship) determines the type of propagating centered disturbance—whether continuous wave, discontinuous shock, or combination of both.

Reviewer believes the paper to be sound, but feels that clarity is sacrificed for extreme brevity. For example, it is not explained in what respect a "weak shock" differs from no shock at all.

A. H. Armstrong, England

Fluid Machinery

(See also Revs. 6008, 6141, 6289)

Book—6242. Hammond, R., Water power engineering and some electrical problems, New York, Macmillan Co., 1958, xvi + 302 pp. $10.

The book is written on a very broad basis. It contains review of recent progress in water power engineering and high tension transmission as well as discussion of trends of future developments.

There are five chapters. First chapter—water power industry—contains some statistical data on hydraulic power production (1952), brief review of some new big schemes of development, and principles of engineering design and planning. Special attention is given to underground-power stations which permit concentration of high power at a single point in some cases. Basic data and cost are given for some of them. Author states selection of underground scheme is now based rather on technical and economical characteristics of them than on defense consideration. He foresees very favorable conditions of combination of nuclear power plants for baseload and hydroelectric power as pumped storage or peak load. Therefore some hydraulic power resources, considered previously to be uneconomical for development alone, can be successfully used in the future.

Second chapter reviews progress in design and construction of hydraulic turbines and their speed control. As illustration, a description of some typical installations is given. Special attention is given to high head Francis and Kaplan turbines with an explanation of conditions which produce cavitation problems and requirements of pumped storage to design of turbines and pumps. Methods for testing turbine and its parts at power plant, at factory, and model tests in laboratories are described, as well as modern methods for checking cavitation characteristics of turbines and pumps and new equipment used for that (Escher-Wyss 1955).

Third chapter contains description of modern methods of protecting high-voltage equipment (transmission lines, bus-bar systems, transformers and alternators) against damages by overvoltages and flashovers and arising electrical problems. Properties of insulating materials, especially of new products, are described and compared.

Fourth chapter includes description of some new hydroelectric developments (large schemes) in several countries, except USSR, with indication of new solutions and discussion of modern trends in design and planning schemes of development, in design of water turbines and hydraulic structures.

Fifth chapter contains brief description of different types of tidal power plants. Special requirements for the design of turbines for tidal plants are indicated. Some economical aspects of the tidal power development are discussed.

The reviewed book is not a substitute for textbooks or handbooks in this field but it is a very useful and essential complement to them. Author reached his goal to write a book useful for all connected with water power development or studying this field of engineering. The book gives the latest ideas in this field, with practical approach.

I. J. Moskvitinoff, USA

Book—6243. Nechleba, M., Hydraulic turbines—their design and equipment (in English), Prague, ARTIA, 1957, 636 pp. $7.50

The four parts of this work contain a thorough description of all important data, amply illustrated, providing not only a textbook but also a handbook for hydraulic engineers. Part I contains introduction to theory of hydraulic turbines with special discussion of hydraulic energy, motors, classifications of turbines, relation between head, flow rate and output, action of the flow on the duct, constant pressure and overpressure, draft tube, cavitation, examples of turbine designs and output control methods, hydraulic similarity, specific speed and velocities, efficiency of dimensions, operation variations, important characteristics, Braun's diagrams, requirements of manufacture. Part II refers to turbine design of various types, especially to Francis turbines, propeller and Kaplan turbines, Pelton turbines, with all details, characteristics and arrangements. Part III thoroughly discusses equipment of

hydraulic turbines with basic principles of controllers, their general layout, calculation and checking, purpose and design of thrust bearings, conduits, calculation of pipes, water hammer, surge tanks, closing organs for conduits, pressure regulators. Part IV describes starting operations and guarantee measurements.

References are made to 52 books in various languages and to 83 articles published in periodicals. Author is internationally known as hydraulic specialist. He is professor of Hydraulics at the Slovak Technical University in Bratislava, member of Czechoslovakia Academy of Science and consulting engineer of reputation.

J. J. Polivka, USA

6244. Proskura, G. F., Theory of a plane grid in a bounded flow (in Russian), *Sb. Tr. Labor. Problem Bystrokhod. Mashin i Mekhanizmov Akad. Nauk USSR* no. 5, 3-18, 1955; *Ref. Zh. Mekh.* no. 5, 1958, Rev. 5347.

Author determines some characteristics of an immovable straight grid from a finite number of blades, introducing arbitrarily a conditioning coefficient of the change in velocity at this grid, depending on the distance between the leading in walls, and making use of it in the empirical expression for the cavitation coefficient of the hydroturbine. The results of the calculation do not agree with the experimental data. The contents of the paper do not correspond with its title in that the characteristics of the flow past the bounded grids are not investigated.

G. Yu. Stepanov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6245. Dean, R. C., Jr., On the necessity of unsteady flow in fluid machines, *Trans. ASME,* **81** D (*J. Basic Engng.*), 1, 24-28, March 1959.

Stated purpose of paper was to demonstrate that flow in "frictionless fluid machines" must be unsteady if work is to be done on the fluid. Paper lacks rigor and most readers will have difficulty trying to find author's thesis. Trouble starts when author indiscriminately mixes the Bernoulli equation (conservation law for an isolated flow system) and the steady-flow energy equation for nonconservative systems. This leads to a meaningless result (Eq. [5]); then after a loose proof of Euler's equation and despite the fact reader is not told "what happens as the blades chop up the streamlines," it is discovered that Bernoulli equation is a conservation law! (Author does not consider time-dependent solutions, and that system is isolated). Author uses one-dimensional theory only; this is hardly adequate. In more general terms using Euler equation, the Second Law and Definition of stagnation enthalpy one can find, grad $h_0 - T$ grad $S - \mathbf{V} \times$ curl $\mathbf{V} + \mathbf{V}_t = 0$. Thus author's Eq. [26] is true for an ideal flow in an isolated system and is a conservation law. To avoid "difficulty... as the streamline lashes about in an unsteady flow" author proceeds to study total derivative of stagnation enthalpy. Reviewer cannot see what author's difficulty is and how he resolves it. A general statement of author's Eq. [28] is, $Dh_0/Dt = h_{0t} + T(\mathbf{V} \cdot \text{grad} S) - \mathbf{V} \cdot \mathbf{V}_t$ which reduces to $Dh_0/Dt = h_t$ if S is constant.

Reviewer questions logic of this paper and feels author has not really studied flow in a machine.

R. A. A. Bryant, Australia

6246. Grechin, M. A., Experimental investigation of the hydromechanical characteristics of propeller outlines (in Russian), *Trudi Tsentr. N.-i. In-ta Morsk. Flota* no. 7, 82-95, 1956; *Ref. Zh. Mekh.* no. 5, 1958, Rev. 5412.

The analysis is described of the results of working over a series of data obtained from blow-through tests in the Leningrad University's aero tunnel. The tests were made by the Central Scientific Research Institute of the marine fleet with the objects of improving the logarithmic diagram drawn by V. M. Lavrent'ev in 1945-46 on the basis of working-over and averaging of different experimental data regarding propeller outlines, known at that time. The basic series used in the special tests consisted of five outlines with relative thicknesses of from 0.2 to 0.05. In order to clarify the point of the influence of curvature of the outline four additional outlines were tested; these represented modifications of the curvature in the basic outlines of nos. 3 and 4 with relative thicknesses of 0.10 to 0.075. The experimental investigation included the determination of c_x, c_y and c_m in conditions of a circular blow-through of the outlines, and also the determination of the distribution of pressure by the method of drawing off each of the nine models at 23-25 points within the limits of change of the angle of attack up to the critical. In the result, the V. M. Lavrent'ev diagram is brought in, establishing the linkage between the blade's components and its hydrodynamic characteristics for the tested series of outlines.

I. V. Girs

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6247. Edel', Yu. U., Some matters arising from an investigation of the loss of energy in bucket turbines (in Russian), Hydroturbine construction **4**, Moscow-Leningrad, Mashgiz, 1957, 55-72; *Ref. Zh. Mekh.* no. 5, 1958, Rev. 5352.

An examination is made of the loss of energy in bucket turbines: a short review is given of published papers dealing with the subject; the many-sided nature and the small amount of study connected with the loss phenomenon are emphasized; the possibility of a significant increase in the energetic qualities of the bucket turbine is noted.

N. A. Kolokol'tsov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6248. Arouson, A. Ya., Application of the theory of thin rods for the calculations of the working wheel of a radial-axis turbine (in Russian), Hydroturbine construction. Moscow-Leningrad, Mashgiz, 1957, 182-194; *Ref. Zh. Mekh.* no. 5, 1958, Rev. 6072.

A method is proposed for the calculation of the stressed condition of the blades of the working wheel of a radial-axis turbine on the hydrodynamic pressure, using the theory of thin rods. The axis of the rod is divided into two positions: a section of the straight part and an arc of the surrounding space. The moments of inertia of the transverse section and the angle of actual torsion are assumed to be constants. The upper end of the blade is taken to be rigidly fixed in the upper rim (of the wheel), the lower is fixed in the lower rim, but can change position together with it.

V. K. Prokopov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6249. Ergin, A., The calculation of the volute cross section of a centrifugal pump to obtain a constant pressure distribution around the periphery of the volute (in English), *Bul. Istanbul Tekn. Univ.* **11**, 1, 61-95, 1958.

An exceptionally detailed treatment of volute design, useful to those engaged in the efficiency improvement of centrifugal pumps. Author derives a 2% gain in efficiency by using a volute design with which a constant pressure distribution around the volute's perimeter is obtained. The theoretical work is correlated with experimental efforts combined in three experiments with a single entry pump (9.5-inch impeller diam, 8 vanes, and speeds between 1200 to 1550 rpm). The pressure was measured at 55 locations, 7 of which were in the outlet region and 48 around the periphery of the volute. A mathematical method is offered for the calculation of such volute; however, since some empirical parameters were used, additional experimental work would be required.

The treatment is of practical value. The data offered in a number of tables and graphs contribute to better understanding of the flow, as well as pressure phenomena in a volute of a single-entry, single-exit centrifugal pump. Reviewer believes that a correlation of this work with that of Dr. U. M. Barske at the Royal Aircraft

Establishment (Farnborough 1950–55) would offer some desirable simplification for the presented methods. Dr. Barske's work in centrifugal pumps (i.e., R.A.E. Tech. Notes RPD 9, RPD 40, RPD 77, RPD 127, etc.) is among the most interesting for applied research and development. C. R. Bell, USA

6250. Ergin, A., The design of the volute of centrifugal pumps, taking into consideration the static pressure distributions (in French), *Houille Blanche* **13,** 6, 639–660, Nov. 1958.

By considering the flow in the volute at any angle of advance as composed of the sum of a circumferential jet flow and of a volute flow already existing, a method is given of calculating volute area to give a uniform peripheral static pressure distribution around the casing. Step-by-step calculation with certain arbitrarily selected values is necessary. Tests with an impeller of 9-½-inch diameter having 8 vanes of 24° angle showed that redesign of the volute according to the theory resulted in a considerably more uniform pressure distribution and an increase in efficiency from 0.66 to 0.68. D. G. Shepherd, USA

6251. McCune, J. E., A three-dimensional theory of axial compressor blade rows—Application in subsonic and supersonic flows, *J. Aero/Space Sci.* **25,** 9, 544–560, Sept. 1958.

A small-perturbation theory for the description of the steady flow in axial compressor blade rows is developed by superposition of cylindrical wave functions.

Paper will be appreciated as an interesting theoretical contribution to the subject. However, due to unrealistic linearization of the problem, it cannot have more than academic significance for the advanced compressor designer.

P. G. Schwaar, France

6252. Muesmann, G., Correlation of the flow characteristics of a rotor in a compressor with the flow around a single airfoil (in German), *Z. Flugwiss.* **6,** 12, 345–362, Dec. 1958.

This paper is a very useful contribution to the continuous effort to further the knowledge leading to the increase of compressor efficiencies. Author offers a method by which the well-established single airfoil characteristics can be applied to the evaluation and selection of vane profiles for compressor rotors.

An impressive volume of references has been used in the competent mathematical derivation of the correlation method between the airfoil data and rotor-vanes configurations. The theory was substantiated by a well-instrumented experimental program, in which a 500-mm diam rotor with six exchangeable vanes was used. The Göttingen airfoil profiles nos. 795 to 798 have been used. Correlations at 125 to 2000 rpm were obtained with considerations of practical Reynolds numbers and other pertinent parameters in applicable configurations.

It may be concluded that the offered method allows the application of single airfoil wind-tunnel data to the design and optimization of high efficiency compressor rotors.

C. R. Bell, USA

6253. El'perin, I. S., Reduction of the radial dimensions of centrifugal compressors, used for the pressure feed of transport diesels (in Russian), *Trudī N.-i. Labor. Dvigatelei M-va Transp. Mashinostr. SSSR* no. 3, 65–87, 1957; *Ref. Zh. Mekh.* no. 5, 1958, Rev. 5241.

The influence of the coefficient of consumption on the size of the diameter of a compressor is investigated. According to the calculations of the author the total relative losses in the compressor are at a minimum when the coefficient of consumption lies between 0.28 – 0.4. Therefore at peripheral velocities of 300–400 m/sec, the increase of the normally used value for the coefficient of consumption of 0.3 to 0.4 will be accompanied by a decrease in the diameter of the wheel by 10–12% without reducing the compressor's effectiveness. A. I. Loshkarev

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6254. Albring, W., Euler diagram for the design of axial blade wheels (in German), *Maschinenbautechnik* **7,** 9, 467–477, Sept. 1958.

Starting with well-known statement that successful design consists of achieving desired fluid deflection with smallest possible cascade losses, author postulates for his method availability of wind-tunnel measurements on two-dimensional or special rotating wheel cascades. "Euler" diagram is presented as plot of mean relative angle versus ratio of pressure to flow parameters, resulting in network of lines of equal inlet and exit angles. Point in diagram represents deflection through cascade; twisted blade appears as curve. Both pump and turbine range of parameters are included, also auxiliary plots of flow parameter and parameter ratio versus absolute angles. Classification of accelerating, decelerating and constant pressure cascades is given. Impeller cascade similarity parameter is related to loss coefficient, based on uniform mean axial velocity head and uniform radial distribution of head. Empirical values of cascade parameter as function of specific speed (for blowers) are included in another form of diagram, together with limiting line of relative velocity ratio for attached flow, based on stationary deceleration cascade. Special case of twisted impeller blades, used in conjunction with straight guide vanes, is discussed. Euler diagram with lines of constant degree of reaction is presented, also similar plot with lines of constant products of head and flow parameters, for minimizing size.

Design of circular arc guide vanes is demonstrated. Either minimum loss coefficient, or separation-safe range of inlet angles may be used as criterion. Solidity, angle of attack, mean relative angle, head-flow parameter ratio and cascade loss coefficient are contained in plot used with velocity diagrams. Relation between pressure recovery ratio of deceleration cascade and loss coefficient is given, together with limited-validity approximation formula for loss coefficient as function of head-flow parameter ratio and mean relative angle. Test results on plane turbine cascade are shown in plot. Efficiency of cylindrical cascade section is derived as function of head and flow parameters and cascade loss coefficient. Lack of experimental knowledge of loss coefficient dependence on solidity, radius ratio, angles, and other parameters is pointed out. Attempt is made to relate drag and lift coefficients empirically, obtaining ultimately cascade loss coefficient as function of lift-drag ratio, head and flow parameters, and mean relative angle. Caution concerning separation check is advised. Corresponding formulas for efficiencies are obtained. Optimum values of lift-drag ratio must be obtained from tests and will probably depend on camber and thickness distribution. Approximation formula for mean lift-drag ratio as function of radius ratio is quoted. Warning is voiced against use of loss coefficient of mean cascade as characteristic of entire blade, except for very small ratios of blade width to length. Several examples are worked and discussed.

Author suggests in his summary that for water turbines and pumps critical cavitation numbers, with head as parameter, could be plotted for design purposes in similar fashion. All diagrams in paper are for two-dimensional, incompressible flow. Frequent use is made of the assumption that inlet and outlet absolute angles are 90 degrees, for pumps and turbines respectively.

T. Ranov, USA

6255. van Manen, J. D., Wake-adapted screw series designed by the induction factor method, *Inter. Shipbldg. Progr.* **5,** 49, 411–422, Sept. 1958.

In applying the circulation theory to the design of marine propellers, the primary difficulty has been to include the effects of the interactions between the circulation about the several blades. Recently methods have been developed for designing propellers by analytical methods that match given wake distributions, but these methods require much numerical work. The effects of the blade

interactions have been systematized, computed by machine and presented in the form of charts so that, with these, efficient and accurate propeller designs may be prepared, with a minimum of numerical work, to meet special conditions.

F. E. Reed, USA

Flow and Flight Test Techniques and Measurements

(See also Revs. 6231, 6306, 6311)

6256. Karolyi, Z., and Starosolszky, O., Irrigation water measurement, Part II, Proceedings of the Research Institute for Water Resources, no. 5 [Az öntozoviz mérése II. Tanulmányok és Kutatási Eredmények. 5], Budapest, Vizgazdálkodási Tudományos Kutató Intézet, 1958, 28 pp. + 26 tables.

Paper gives results of 1957 investigations in pumping plants and in intakes to open channels: comparison of measuring devices, pulsation of flow, clogging of commercial meters, effect of air bubbles on the accuracy of venturi tubes. By-pass with a conventional water meter was investigated for a venturi tube and for an elbow. Venturi tube in connection with an open surface intake and a Russian measuring gate by Pikalov were tested in a laboratory and in field. Detailed sketches are presented for the measuring elbow, for the simple venturi tube of the Tiszai-Kaffka type, made from conical fittings, the venturi tube and Pikalov gate for open channel, the air tank for elimination of air bubble influence, and also some additional drawings for the venturi flumes, covered in the first part of this practical publication, (1957), for hydraulic engineers, particularly for irrigation works.

S. Kolupaila, USA

6257. Katys, G. P., Flow meters of small inertia for the measurement of pulsating flows (in Russian), *Priborostroenie* no. 8, 29–31, 1957; *Ref. Zh. Mekh.* no. 5, 1958, Rev. 5633.

In this summary of data from published literature, a short description is given of the various ways of measuring pulsating flows of liquids and gases: (1) Winged flowmeters for measuring flows with a pulsation frequency of up to 80 Hertz; (2) different ionizing devices for the measurement of flow; (3) gyroscopic flowmeters for liquids or gases with pulsations up to frequencies of 300 Hertz; (4) flowmeters working on the principle of measurement of Coriolis' forces for liquids or gases in flows with pulsations of up to 300 Hertz; (5) flowmeters for flowing about with a sensitive element in the form of a diaphragm; (6) flowmeters with wire thermoanemometers acting as a sensitive element; (7) ultrasonic flowmeters for liquids; (8) electromagnetic flowmeters—a flowmeter with a variable magnetic field of a frequency of 2–5 Hertz is referred to. For the measurement of slowly changing flows flowmeters are used with variable magnetic field of a frequency of 50 Hertz.

M. R. Shamilev

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6258. Dubrova, T. N., Volumetric meters for liquid discharges, fitted with oval driving gear (in Russian), Heat energy apparatus and regulators, Moscow-Leningrad, Mashgiz, 1954, 232–249; *Ref. Zh. Mekh.* no. 4, 1958, Rev. 4364.

Data are given governing the selection, treatment and utilization of meters for liquid discharges (SRZh) fitted with oval-shaped driving gear. From the many and varied methods used for the industrial measurement of liquid discharge, a method of volumetric measurement was selected as having a number of advantages over others (a small factor of error ±0.3–1.5%, the possibility of measuring viscous liquids including pastes, a small loss of pressure, a wide field of application). Tests carried out with three groups of volumetric SRZh (with rectilinear return-forward, with complex and rotating motions) using water and petroleum products of different viscosities demonstrated the superiority of the SRZh apparatus fitted with oval driving gear. The working principles of the SRZh are described, also its construction, calculations, results of testing, the technology of its manufacture, and some of the more usually used types of the SRZh for liquid fuels and lubricants.

A. L. Leonov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6259. Nikitin, B. I., Liquid-flow measurements by the electromagnetic method (in Russian), *Priborostroyenie* no. 7, 13–15, 1956; *Ref. Zh. Mekh.* no. 2, 1958, Rev. 2047.

Author finds the principal defect in flowmeters with convergent elements, vanes, etc., to be the considerable resistance they offer to the flow and the dependence of their indications on the density and temperature of the liquid, the character of the flow, and other factors. A comparison of previously-used flowmeters with the latest, modern types (radioactive, acoustic and electromagnetic) leads author to the conclusion that instruments based on utilization of the laws of electromagnetic induction possess undoubted advantages. If a condition is set up in which the liquid in motion intersects the lines of force of a magnetic field, then in water as in any other conductor, an electromotive force will be generated which will be proportional to the velocity of motion (rate of flow) of the water. For successful realization of the measurements it will be necessary for the input resistance of the measuring instrument to be many times greater than the resistance of the liquid between the measuring electrodes, in order that the electrode material shall have the least polarization emf; and, in addition, the measuring instrument must be provided with adequate amplifying means. Developments in the direction of the design of flowmeters with constant magnetic fields have shown the necessity of overcoming great difficulties in the elimination of distortion of the instrument readings due to polarization emf, and of obtaining a high degree of amplification of the d-c electromotive force. Recourse to variable (fluctuating) magnetic fields would in great measure eliminate the aforesaid difficulties but there would instead be inductance and capacitance effects, the elimination of which would again present serious difficulty. The most favorable conditions will be obtained by the use of alternating currents of lowered frequency (of the order of 10 c/s). The difficulty in this case, however, is the development of a sufficiently powerful generator. The great majority of developments in the sphere of electromagnetic flowmeters relate to the use of magnetic fields of industrial frequency. The accuracy of measurement by such flowmeters is of the order of 1–2%. The difficulties associated with the application of the electromagnetic method of flow measurement are considered by the author to be surmountable, and the prospects of introduction of this method on an industrial scale are undoubtedly good.

N. M. Ivanov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6260. Toye, T. C., The ring balance differential pressure meter, *Metallurgia, Manch.* **59,** 354, 209–210, Apr. 1959.

6261. Kharlamov, A. A., Measurements in a pulsating airflow (in Russian), *Pribory i Tekhn. Eksperimenta* no. 1, 102–105, 1957; *Ref. Zh. Mekh.* no. 2, 1958, Rev. 2039.

An experimental investigation of the readings of a pitot tube in a periodically pulsating airflow of low velocity. Measurements were made with a thermoanemometer (hot-wire instrument) and by the capacitance method, of both instantaneous and time-averaged values of the static and dynamic pressures. It is shown that the experimental equipment used enabled the magnitude of velocity pulsations to be determined with an accuracy within 5–10%. The

time-averaged value of the fluctuations of the dynamic and velocity head in a pulsating flow within a range up to 20 m/sec in amplitude and 50 c/s in frequency agrees with the indications of the pitot tube. V. I. Goryachev

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6262. Goryaga, G. I., and Shvidkovskii, E. G., Hysteresis of the viscosity of molten metals (in Russian), *Vestn. Mosk. In-ta, Ser. Matem., Mekhan., Astron., Fiz., Khimi* no. 2, 71–76, 1956; *Ref. Zh. Mekh.* no. 4, 1958, Rev. 4349.

An investigation was carried out, using a viscometer of rotating type, on the relation of viscosity to temperature of alloys of lead-bismuth and of pure lead. It was established that melts containing undissolved admixtures possess viscosity hysteresis. Melts purified by removal of the undissolved admixture by vacuum filtration do not possess viscosity hysteresis. The explanation for the given phenomenon lies in the circumstance that the undissolved admixture retards the process of the change of type of coordination of the atoms (and consequently the viscosity) in the change-over from the low-temperature form of atomic arrangement to the high-temperature form. A. I. Golubev

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6263. Bradfield, W. S., and Sheppard, J. J., Jr., Microschlieren—A technique for the study of details in compressible flow, *Aero/Space Engng.* **18,** 5, 37–40, 56, May 1959.

Paper describes apparatus developed for observing flow processes around probes in thin boundary layers. The instrument provides high magnification of a small field with sufficient contrast to show details. A sharp focusing property reduces the effects of regions of flow along the optical axes not under investigation. The optical system may be used as a focused shadowgraph, Toepler schlieren or a phase microscope.

Optical system described gives a 6 to 40-power image on the negative of a field approximately 3/4 to 1/4 in. in diameter with an overall magnification possibility of 20 to 100 in the final positive print. The depth of field at about 30 power for a typical objective is about 1 mm and the range of working distance is from 1½ in. to 5 ins.

A high pressure mercury arc-lamp, which can be used continuously or flashed through a 10-mil diameter pinhole and lens system, is the light source. A commercial 8 × 10 view camera with a bellows draw of 30 in. serves as the film holder, and as it contains no optical components changing film does not affect the optical adjustment of the system.

Some photographs are shown illustrating the performance of the system and authors conclude that technique should be a useful tool for detailed study of small flow fields, with which reviewer agrees. A. F. W. Langford, Australia

6264. Koenig, D. G., Low-speed tests of semispan-wing models at angles of attack from 0° to 180°, *NASA Memo* 2-27-59A, 21 pp. Apr. 1959.

Data are presented for swept- and unswept-wing models with aspect ratios from 2 to 6. Except for an aspect-ratio-2 delta wing, the models had a taper ratio of 0.5 and NACA 64A010 airfoil sections. Most of the models were tested with and without a full-span trailing-edge flap. The Reynolds numbers of the tests ranged from 1.5 to 2.2 million. Approximate corrections for blockage have been applied to the data. From author's summary

6265. Johnson, J. L., Jr., Wind-tunnel investigation of a small-scale sweptback-wing jet-transport model equipped with an external-flow jet-augmented double slotted flap, *NASA Memo* 3-8-59L, 41 pp., Apr. 1959.

The investigation consisted of force tests of the complete model and of the wing alone for an angle-of-attack range from −8° to 12° and for momentum coefficients up to about 3.0. Tests were made of the wing alone to study the effects of varying the spanwise extent of blowing on the full-span flap. All tests were made at a Reynolds number of about 260,000 based on the mean aerodynamic chord of the wing. From author's summary

6266. Bloxsom, D. E., Jr., Supersonic aerodynamic experiments using very high temperature air wind tunnels, *Jet Propulsion* **28,** 9, 603–609, Sept. 1958.

Pioneering studies leading to development of first Hotshot tunnel at AEDC are described. Experiments were performed in free jet flow at Mach 4 and 5 with stagnation temperatures and pressures running to 16,000 F and 40,000 psi respectively. Studies included equilibration time for start of flow, flow structure around models as indicated by self-luminosity of the gas, drag coefficients of spheres in the laminar regime, laminar heat-transfer measurements and throat erosion. Heat-transfer measurements were crude compared to subsequent Hotshot work at Tullahoma and elsewhere, but free-motion technique of measuring drag coefficients is promising. Growing popularity of Hotshot tunnels is well known. While subsequent developments have superseded some of the early work reported here, much of the analysis, especially that concerned with throat erosion, will be of interest to the experimental aerothermodynamicist.

D. Bershader, USA

6267. Bloxsom, D. E., Jr., Use of capacitor discharges to produce high temperature, high pressure aid, *Jet Propulsion* **28,** 9, 609–614, Sept. 1958.

Author describes experimentation on the heating of air under constant volume conditions by spark discharge of a charged capacitor bank inside a high-pressure chamber or "bomb." Such apparatus represents the power supply and driver end of spark-heated or so-called "Hotshot" tunnels; and Bloxsom, one of the originators of the first "Hotshot" at AEDC, presents results of definite interest to all who are concerned with such facilities. Author finds that with proper control of parameters energy transfer from electrical to thermal form is made with efficiencies considerably more than 50%. Because of power levels of the discharge, impurities enter the gas from the electrodes, insulators and nozzle throat through which the air is released at stagnation pressures and temperatures as high as 40,000 psi and 16,000 F respectively. Subsequent experience, however, indicates that this is not an insurmountable problem for engineering and test applications if one is willing to use replaceable tungsten inserts at the throat. D. Bershader, USA

6268. Tournier, M., and Laurenceau, P., Magnetic suspension of a model in a windtunnel (in French), *Recb. Aëro.* no. 59, 21–26, July–Aug. 1957.

Thermodynamics

(See also Revs. 5902, 6136, 6212, 6262, 6298, 6299, 6307)

Book—6269. Van Wylen, G. J., Thermodynamics, New York, John Wiley & Sons, Inc., 1959, xxiii + 567 pp. $7.95.

Book is directed mainly to students. The materials treated include definitions and zeroth law; thermodynamic properties; work and heat; first law; second law; availability and irreversibility; power and refrigeration cycles; flow processes, thermodynamic relations; chemical reactions; equilibrium. There are examples and numerous problems for the class room and selections of tables of thermodynamic properties.

The treatment follows classical lines. Author writes in the preface that the book has three aims: An approach directed toward students, a rigorous treatment of fundamentals and a distinctly engineering perspective. Reviewer finds that the first and third objectives are quite well fulfilled. In case of second one, although author has evidently tried, he is less successful and there are instances where the treatment is not strictly rigorous according to modern standards. To mention one example: heat unit is defined as the quantity of heat required to raise the temperature of a certain mass of matter over certain amount, before introducing internal energy and first law. There is then no way to compare quantity of heat transferred at other temperature levels. Another is the "absolute" entropy. This is misleading, especially since author chooses not to treat third law. In case of availability, author introduced heat flux but limited heat transfer at surrounding temperature. This simply means that only state change prescription of the system is considered but not for given heat flux at prescribed temperature. It is unfortunate that author does not use the term internal entropy production, which would make the definition of irreversibility much more natural.

Some obvious oversights are annoying. Table 15.4 is entitled "Enthalpy, Entropy and Gibbs Function of Formation of Various Substances." Actually the entropy listed is the "absolute" entropy in author's terminology and its numerical values have not been brought in conformity with Table A.9. Example 15.23 contains a numerical error.

In spite of these criticisms, reviewer feels this book still is one of the most precise and rigorous texts at elementary level. The choice of materials is well balanced and the treatment clear.

L. S. Dzung, Switzerland

6270. Christie, D. E., Some thermodynamics properties of a mapping, *J. Franklin Inst.* **267,** 2, 119–133, Feb. 1959.

Author shows that, under graphical representation, comparison of P, V and s, T behavior in a thermodynamic relationship can be couched in terms having topographic significance, primarily that areas are preserved in these two coordinate systems and slope ratios are in projective correspondence. He stresses that graphical representation gives command of general and specific behavior and interpretability over such further quantities as specific heat capacities and bulk moduli. His graphical techniques effectively counter and indeed minimize the classical elusiveness of this behavior. The preservation of area is topologically immediate under transformations of constant energy per mole; the projective property of slope ratios is not surprising since a ratio of slopes is a ratio of ratios—a *cross-ratio* or projective invariant. His written style is clear and direct.

The article has pedagogical significance beyond the thermodynamics field—especially for Americans—through the opening sentence, "It is often instructive to examine a familiar subject from an unaccustomed point of view." Author's skill with conventional graphical representations, his repeated and effective use of feedback from these representations toward greater scope, penetration and interpretability for his subject matter belie the current American penchant in derogation of the graphical method to rely solely on rigid analytical tools of a less responsive, open nature. The flexibility, liveliness and productivity of the author's disucssion are gratifying.

The preservation of area prompts the author to observe that the Jacobian of the topological $P,V:s,T$ transformation is unity and hence to the suggestion (a typical graphical motivation) that the unit value of the Jacobian can be employed as one of a set of postulates for thermodynamics coeffective with its three classical laws. The intriguing question of what the complementary postulates would be is left open.

D. P. Adams, USA

6271. Torocheshnikov, N. S., Leites, I. L., and Brodianskii, V. M., A study of the effect of temperature separation of air in a direct-flow vortex tube, *Soviet Phys.- Tech. Phys.* **3,** 6, 1144–1150, Feb. 1959. (Translation of *Zh. Tekh. Fiz., Akad. Nauk SSSR* **28,** 6, 1229–1237, June 1958 by Amer. Inst. Phys., Inc., New York, N. Y.)

Direct-flow and counter-flow vortex tubes have been constructed and tested. The process of vortex temperature separation occurs mainly near the nozzle. Therefore, the hypothesis of equalization of angular velocity does not correspond to the experimental observations. Under otherwise equal conditions the direct-flow vortex tube is less efficient than the counter-flow tube. The possibility is indicated of improving the overall characteristics of the vortex tube by using a combined direct-flow and counter-flow construction, giving two streams of cooled gas at different temperatures. In the region of supersonic flow through the nozzle the thermodynamic efficiency of the vortex process of temperature separation decreases with increase of the pressure before the nozzle.

From authors' summary

6272. Tempelmeyer, K. E., High temperature gas mixtures for simulating air and other planetary atmospheres, Heat Transf. and Fluid Mech. Inst., Univ. Calif., Los Angeles, Calif., June 1959, 207–221.

A set of simultaneous equations has been proposed for specifying a mixture of gases which has macroscopic properties similar to those of another gas or some other gas mixture at the same pressure and temperature. Although the equations directly consider only a few basic molecular properties (mean molecular mass, number of degrees of freedom, and collision cross-sectional area), the gas mixture they specify also duplicates many of the equilibrium and transport properties of the simulated gas or mixture. Furthermore, certain similarity parameters for fluid flow and heat transfer are also matched.

Air at temperatures up to the dissociation range may be simulated by mixtures primarily composed of a combustion gas with monatomic and diatomic gases as additives. Moreover, the temperature variation of the properties of air is closely reproduced by certain of these air-equivalent mixtures. Gas mixtures equivalent to the proposed atmospheres of other planets may also be determined. For example, the atmospheres believed to exist on Mars or Venus can be duplicated at temperatures near 600 R by mixtures which contain a large proportion of air with gases of the Freon family as additives.

From author's summary

6273. Hart, E. W., Thermodynamics of inhomogeneous systems, *Phys. Rev.* (2) **113,** 2, 412–416, Jan. 1959.

Paper is concerned with one-component systems which are restricted to liquid or solid materials whose local energy density is pointwise dependent upon the space derivatives of the density at the point in question. Equilibrium equations are obtained in terms of the dilatation, the free energy per unit volume, the entropy per unit volume, and the number of molecules per unit volume.

The method is amined at a description of transition interfaces separating two phases. Questions of residual stresses and/or strains in the reference equilibrium state are apparently ignored. A paper by Cahn and Hilliard in the *J. Chem. Phys.*, **28,** pp. 258–267 is the principle reference.

W. C. Orthwein, USA

Book—6274. Prigogine, I. (edited by), Advances in chemical physics. Vol. I. New York, Interscience Publishers Inc., 1958, xi + 414 pp. $11.50.

This volume, one of similar series of Advances, proposes to report extensively but lucidly on topics of current importance. The several chapters are concerned with applications of statistical mechanics to thermodynamic, kinetic, and transport problems of chemical physics. In "Statistical-mechanical theory of transport processes. X. The heat of transport in binary liquid solutions," R. J. Bearman, J. G. Kirkwood, and M. Fixman continue their series of earlier papers upon transport properties of binary solutions in which both equilibrium and nonequilibrium energy distri-

bution contributions are considered. The results obtained reduce to a form similar to previously derived expressions in the special case of a regular solution. J. Bigeleison and M. Wolfsberg, "Theoretical and experimental aspects of isotope effects in chemical kinetics," review the transition-state theory with regard to the effect of isotope mass differences upon the observed reaction rate. Experimental methods are discussed, with special emphasis given to hydrogen isotopes in the gas and liquid phase and carbon in decarboxylation reactions. "Dielectric properties of dilute polymer solutions," by L. de Broucke're and M. Mandel, is a theoretical review of aspects of polymer-solvent systems as indicated by dielectric properties. The authors derive an energy barrier model for the dielectric relaxation time in dilute polymer solutions which is consistent with all of the experimental data available.

G. Caseri discusses the foundations of the transition-state theory in "Some physical aspects of gaseous chemical kinetics." New experimental data for the hydrogen-deuterium reaction establish a consistent base for the theory, while the nonequilibrium energy distribution effect upon the transition state is shown to be small. "Transport processes in liquids," F. C. Collins and H. Raffel, is a comprehensive review of the theoretical approaches to the calculation of molecular transport properties. None of the existing models of the liquid state gives a completely satisfactory explanation of transport properties. In "The relation between structure and chemical reactivity of aromatic hydrocarbons with particular reference to carcinogenic properties" R. Daudel summarizes some of the problems considered in a forthcoming quantum chemistry book. Techniques of using valence bond theory to predict relative reaction rates of homologs are demonstrated. "Molecular theory of surface tension," by A. Harasima, is a discussion of current developments in the statistical-mechanical theory of surface tension. Fowler's assumption of interfacial mathematical discontinuity is experimentally and theoretically criticized. H. C. Longuet-Higgins, "Recent developments in molecular orbital theory," reviews the applications of MO theory to the structure of unsaturated hydrocarbons. An empirical form of the linear combination of atomic orbitals yields a complete description of the properties of unsaturated hydrocarbons. "Intermolecular forces and equations of state of gases," by T. Kihara, is a mathematical description of the effect of nonadditivity of intermolecular forces upon equations of state. For the model of spherically symmetric atoms, the second and third cluster integral was solved. Condensation of unimolecular gases is also discussed. P. Mazur, "On statistical mechanics and electromagnetic properties of matter," gives a complete theoretical description of dielectric, refractive, and light-scattering properties of matter. The purpose is to show the statistical-mechanical relationships between these fields. In "The application of the theory of stochastic processes to chemical kinetics," E. W. Montroll and K. E. Shuler approach chemical kinetics from the microscopic viewpoint.

N. A. Hall, USA

Book—6275. Prigogine, I. (edited by), Proceedings of the international symposium on transport process in statistical mechanics, Brussels, Aug. 1956; New York, Interscience Publishers, Inc., 1958, x + 436 pp. $10.

Included in this symposium volume are forty-eight contributions by theoretical physicists and physical chemists. The theme of the meeting at which these papers were presented was the extension of statistical mechanics to the transport phenomena class of non-equilibrium systems. The great majority of the discussions follow this theme closely, examining various phenomena or extensions of basic equations of statistical mechanisms.

Considerable reference is made to the domain of irreversible thermodynamics but it is examined critically only from the statistical viewpoint. Incidental to the papers are reports of informal discussions occurring following the fourteen sessions at which the papers were presented. N. A. Hall, USA

6276. Gordiakova, G. N., and Sinani, S. S., The thermoelectric properties of bismuth telluride with alloying additives, *Soviet Phys.-Tech. Phys.* **3,** 5, 908–911, Jan. 1959. (Translation of *Zh. Tekh. Fiz., Akad. Nauk SSSR* **28,** 5, 977–980, May 1958 by Amer. Inst. Phys., Inc., New York, N. Y.)

This paper deals with the effect of impurities on the electrical properties of bismuth telluride. The effect of various concentrations of I, Pb, Cu and CuBr was investigated together with the temperature behavior of the electrical conductivity and the thermal emf of the alloyed specimens. From authors' summary

6277. Airapetiants, S. V., and Bresler, M. S., Thermoelectromotive force and excess thermal conductivity of heterogeneous systems, *Soviet Phys.-Tech. Phys.* **3,** 9, 1778–1781, Apr. 1959. (Translation of *Zh. Tekh. Fiz., Akad. Nauk SSSR* **28,** 9, 1935–1938, Sept. 1958 by Amer. Inst. Phys., Inc., New York, N. Y.)

In this work, the coefficient of the thermal emf of a polycrystal, the increase in the thermal conductivity of a polycrystal due to the nonhomogeneity of its thermoelectric properties, and the coefficient of the thermal emf of a matrix system, in cases when the density of the matrix or the density of the inclusions is low, were calculated.

Previously, the coefficient of the thermal emf of a statistical mixture was calculated; in this work the coefficient of the thermal emf of two types of heterogeneous systems is calculated: polycrystal and matrix systems.

A heterogeneous system is called a matrix system if one of the phases forms a continuous matrix in which the ingrained particles of the other phase (inclusions) are everywhere separated from each other by the matrix phase. From authors' summary

6278. Frontas'ev, V. P., New data on the thermal conductivity of water in the range 10 to 60 °C, *Soviet Phys.- Tech. Phys.* **3,** 8, 1696–1700, Mar. 1959. (Translation of *Zh. Tekh. Fiz., Akad. Nauk SSSR* **28,** 8, 1839–1844, Aug. 1958 by Amer. Inst. Phys., Inc., New York, N. Y.)

The thermal conductivity of water in the temperature interval from 10 to 60 C is investigated. An anomaly is discovered in the temperature dependence of the thermal conductivity in the interval from 30 to 40 °. From author's summary

Heat and Mass Transfer

(See also Revs. 5900, 5902, 5921, 5922, 5923, 5924, 5925, 5926, 5927, 5928, 5929, 6165, 6277, 6278, 6311, 6316, 6330)

Book—6279. Schenck, H., Jr., Heat transfer engineering, New York, Prentice-Hall, Inc., 1959, ix + 310 pp. $9.25.

This book constitutes an elementary introduction to engineering heat transfer. Steady-state and transient heat conduction, natural and forced convection, radiation heat transfer are treated in a simple analytical fashion. Use of graphical and numerical methods to supplement the analytical treatment enhances the practical value of the book. Separate chapters illustrate the engineering application of basic principles. For example, the use of extended surfaces illustrates combined convective and conductive mode of heat transfer. Two chapters are devoted to the basic design principles of heat exchangers, boilers and condensers. The last chapter discusses several methods used in heat-transfer testing. Throughout the book one finds scattered several sections touching briefly on some recent aspects of heat transfer pertaining to liquid metals, supersonic flow, etc.

This reviewer believes that the book constitutes a broad and good introductory text for an undergraduate student. Some printing errors should be avoided in future editions. For example, in reference 1–5 on page 17 one finds in a single sentence 3 errors, two typographical, and one grammatical.

Much as a book of this nature can hardly be complete, this reviewer believes that some of the quoted formulas should be more up to date. This is particularly true for heat-transfer correlations in nucleate boiling. It is also felt that tables containing physical properties, instead of being randomly scattered throughout the text, should be grouped in consistent fashion in an appendix. Finally, this reviewer feels that better effect would have been achieved if author had avoided strong adjectives in describing scientific contributions, such as, "the greatest hydrodynamicist," etc. and also if he would have drawn on more diversified references in discussing certain problems of heat transfer instead of creating unconsciously the impression that most of the contributions to this field have been made by a limited group of university instructors.

B. Zarwyn, USA

Book—6280. Carslaw, H. S., and Jaeger, J. C., Conduction of heat in solids, 2nd ed., New York, Oxford Univ. Press, 1959, xiii + 510 pp. $13.45.

The first edition of the book under review appeared in 1947, and was intended to supersede Carslaw's "Introduction to the mathematical theory of the conduction of heat in solids," which appeared in 1921 and became out of print in 1940.

Compared with the first edition, the present book has three new chapters: one on the change of state, and two short survey chapters on integral transforms and numerical methods. The rest of the chapters, fifteen in number, treat essentially the same topics as the chapters of the first edition. Chapters I to X are a treatise on the use of Fourier mathematics for the solution of heat-conduction problems, and in Chapters XII to XVI the Laplace transformation is the principal tool for solving more difficult problems—Chapters XI, XVII, and XVIII being the new ones mentioned above. In the fifteen revised chapters many new results have been added and many parts of the discussions expanded. These are on heat generation, surface heating, melting, and freezing, geophysical applications, anisotropic media, moving media, and substances with variable thermal properties. The new results of the revised chapters occupy some sixty pages, and the entire book has 124 pages more than the first edition. The connection between some of the results (old and new) and corresponding results in allied fields is worth noting. The reviewer has noted the analogy between heat conduction from a moving source and steady heat convection in irrotational fluid flows and between heat conduction involving a melting surface and unsteady flows of Bingham bodies with a solid-fluid boundary.

In the reviewer's opinion, the book occupies the same position among books on heat conduction as Lamb's among books on hydrodynamics and Love's among books on elasticity, and is more up-to-date than these two great books on continuum mechanics. With it the authors teach not only the theory of heat conduction, but also the theory and application of mathematical techniques employed in solving linear second-order partial differential equations of the parabolic and elliptic types.

C.-S. Yih, USA

6281. Buglia, J. J., and Brinkworth, Helen, A comparison of two methods for calculating transient temperatures for thick walls, *NACA TN* 4343, 11 pp. + 1 table + 6 figs., Aug., 1958.

Two methods, those of Hill and Dusinberre, are discussed and are applied to the calculation of transient inner and outer surface temperatures of a thick (thermally) wall subjected to a specified input function. Two sample problems are chosen and each of the two methods are used to obtain solutions to these problems. Upon comparison with analytic solutions, it is concluded that Hill's method is quite accurate while Dusinberre's method gives a good approximation. When only the temperature histories of the surfaces are desired, Hill's method proves to be faster; but if time-dependent temperature distributions through the wall are required, Dusinberre's method yields quicker results.

A. J. Chapman, USA

6282. Sellerio, A., A method of false position for the approximate solution of the problem of transmission of heat in the stationary regime (in Italian), *Termotecnica* **12,** 7, 306–316, July 1958.

A bar is sectioned into portions of varying length, $\Delta x = x_{i+1} - x_i$, and the steady-state flux of heat into each section is studied. A tentative gradient, $g = -\partial T/\partial x$, is assumed at $x = 0$ and the temperature, heat loss (by radiation, in the examples shown) and heat flux are calculated in successive sections. The error in heat balance is a measure of the accuracy of the initial choice for the gradient.

The method is illustrated in tabular and graphical form, and there follows a discussion of the form of the result in various situations, which, according to the author, may assist and speed the calculation.

R. E. Gaskell, USA

6283. Gryaznov, N. D., Flow of a gas along a channel of variable section while considering the effect of friction and heat emission (in Russian), *Sb. Statei Mosk. Vyssh. Tekhn. Uch-shcha* **39,** 81–89, 1955; *Ref. Zh. Mekh.* no. 5, 1958, Rev. 5208.

Two approximate formulas, derived from known equations in hydrodynamics and heat transfer, give the connection between the geometrical dimensions of the section of a diffuser and the velocity of the flow, and also between the pressure and the velocity in the presence of friction and heat transfer. The theoretical calculation agrees satisfactorily with the data of the experiment with a round diffuser with an angle of expansion of $\alpha = 6°$. It is shown that the efficiency (k.p.d.) of the diffuser when cooled is somewhat higher than when heated.

S. A. Demidov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6284. Dorfman, L. A., Influence of radial temperature gradient on heat transfer from a rotating disk (in Russian), *Izv. Akad. Nauk SSSR, Otd. Tekh. Nauk* no. 12, 64–66, Dec. 1957.

An approximate solution is given for the heat transfer from a rotating disk with laminar flow, when the temperature of the disk and surrounding medium is a quadratic in the radial distance, and for Prandtl number $Pr = 1$. Energy dissipation in the boundary layer is calculated. The quadratic radial temperature distribution is said to be close to that in a gas turbine. The author calculates approximately the heat-transfer coefficient for his case, but with constant temperature along the disk axis, and obtains a value about 50% higher than the heat-transfer coefficient for the case without radial temperature gradient.

Author states that previously calculated values for the heat-transfer coefficient are too low compared to experiment partly because of the neglect of the radial gradient. However, he does not compare his result with experiment.

H. G. Landau, USA

6285. Davies, D. R., Heat transfer by laminar flow from a rotating disk at large Prandtl numbers, *Quart. J. Mech. Appl. Math.* **12,** 1, 14–21, Feb. 1959.

The approximate method of calculating the distribution of rate of heat transfer by laminar flow from a flat plate, described recently by Davies and Bourne, is extended to the problem of a heated rotating disk for an arbitrary radial distribution of surface temperature on the disk. The analysis is applicable if the temperature boundary layer is embedded well within the velocity boundary layer over the disk. By comparing the ensuing numerical results for heat transfer with those calculated from an exact solution, by Millsaps and Pohlhausen in the special case of constant surface temperature, very good accuracy is obtained when the Prandtl number is greater than about 6.

From author's summary by H. Blok, Holland

6286. Tirskii, G. A., Nonstationary flow with heat transfer in a viscous, incompressible fluid between two revolving discs accompanied by fluid influx, *Soviet Phys.-Doklady* **3,** 2, 237–239, Dec. 1958. (Translation of *Dokladi Akad. Nauk SSSR (N. S.)* **119,** 2, 226–228, Mar.-Apr. 1958 by Amer. Inst. Phys., Inc., New York, N. Y.)

This very brief paper only indicates a method of solution. The final results are left as difficult partial differential equations which remain to be solved numerically.

The geometry is for parallel disks which are large in radius compared with the spacing between them. Each disk can revolve with a time-dependent angular velocity, and the disks are porous so that fluid can be admitted through their surfaces with an unsteady velocity. By using a transformation similar to that of von Kármán for a single disk, the Navier-Stokes equations are reduced to a system of three equations for the velocity components in terms of two independent variables. Since the equations are still nonlinear partial differential equations which must be solved simultaneously, their solution appears formidable and is not considered. Assuming the velocity distribution could be found, the energy equation is treated by expressing the fluid temperature as a series expansion. The result is a set of n simultaneous partial differential equations which remain to be solved. R. Siegel, USA

6287. Huber, A., Parallel flow recuperation with temperature-dependent overall heat transfer coefficient (in German), *Öst. Ing.-Arch.* **12,** 1/2, 41–47, Nov. 1958.

The differential equation for heat transfer in a parallel flow recuperator was integrated for the general case (for gases) where the overall coefficient was a function of temperature. A method of handling the counter-flow recuperator was presented.

The effect of a discontinuity in the overall heat-transfer coefficient upon the gas temperatures was studied.

An example was worked out. W. L. Sibbitt, USA

6288. Ivashchenko, N. I., The effect of temperature factor on heat transfer at a turbulent flow of gas in pipes (in Russian), *Teploenergetika* no. 2, 72–75, Feb. 1958.

6289. Sparrow, E. M., and Siegel, R., A variational method for fully developed laminar heat transfer in ducts, *Trans. ASME* **81** C (*J. Heat Transfer*), 2, 157–167, May 1959.

This paper presents an application of the calculus of variation to the problem of computing forced convection heat transfer. The calculation is based upon constant property flow, the constraint of constant energy input per unit length, and the principle of minimum production of entropy. The solution is approximated by the Rayleigh-Ritz method and hence the approximating sequence must satisfy the boundary conditions. Additional restrictions on the sequence of approximating functions are quite loose; nevertheless the rate of convergence of the sequence depends upon the choice of the set of approximating functions. This is clearly illustrated by the difference in the rate of convergence of the several examples. If a complete set is used, then there is some assurance that the series will converge.

Reviewer believes that the approximation technique given in this paper is useful for estimating the forced convection heat transfer from peculiar-shaped passages. The method is most accurate at Prandtl numbers near unity but is probably useful when the Prandtl number is less than ten. The suggested generalization to starting flow in a channel presents no difficulties in principle but may require some care in the details.

E. E. Covert, USA

6290. Sestini, G., Problems in forced heat convection (in Italian), *Riv. Mat., Parma* **8,** 1/3, 5–14, 1957.

Application of a method of solution of the nonsteady convective heat equation is described. Method of Levi-Grevey consists of solving the associated equations of nonconvective field and then expressing the solution of the convective field in terms of an integral differential equation containing the associated solution of the nonconvective field.

Author applies method to two cases of one-dimensional heat transfer: (a) with one-dimensional linear initial temperature distribution and (b) with three-dimensional linear initial temperature distribution. S. Eskinazi, USA

6291. Townsend, A. A., Temperature fluctuations over a heated horizontal surface, *J. Fluid Mech.* **5,** 2, 209–241, Feb. 1959.

Turbulent convection over a heated horizontal plate is experimentally studied and the results indicate that the convection near the surface is independent of distant boundaries and determined by the heat flux and the fluid viscosity and conductivity.

Most striking feature of the observations is that the temperature, temperature gradient, and rate-of-change of temperature all show periods of large fluctuations alternating with periods of relatively small fluctuations. Detailed physical interpretations of these results are given.

Comparison of the experimental results with those obtained theoretically shows that predictions of the similarity theory (which assumes convection to be independent of conduction layer at a sufficient distance from it) do not agree well with the data. The Malkus theory of turbulence (which emphasizes dependence on the conduction layer), on the other hand, is in qualitative agreement with the observed mechanism of convection and in quantitative agreement with the measured distribution of mean temperature.

A brief discussion is given of the effect of a horizontal shearing motion on the convection and the relation of these measurements to those obtained in the earth's boundary layer is discussed.

S. Ostrach, USA

6292. Pavlov, D. F., Formation of a turbulent flow during free convection (in Russian), *Trudi Sredneaz. In-ta* no. 91, 67–87, 1957; *Ref. Zh. Mekh.* no. 5, 1958, Rev. 5488.

An experimental investigation of convection flows, appearing above a warmed round plate 15 cm in diameter, fixed flush in a large sheet of duralumin of a given temperature. A variation of the above was the use of a rectangular plate 45 × 71 cm. A small thermocouple was used to measure the temperature of the air above the plate at different heights while moving it slowly over the diameter of the warmed plate, the thermocouple readings being recorded on a recording tape. Many interesting details of the phenomenon were noted and deductions made; thus, the air did not simply flow from the sides up to different heights, but invariably fell again almost to the point of contact with the plate and then only (finally) rose upwards. This is the gist of the mechanism of the turbulence of an ascending flow. It was established that turbulence makes its appearance at Grashof numbers larger than 10^9.

G. A. Ostroumov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6293. Goulard, R., and Goulard, Madeleine, Energy transfer in the Couette flow of a radiant and chemically reacting gas, Heat Transf. and Fluid Mech. Inst., Univ. Calif., Los Angeles, Calif., June 1959, 126–139.

The determination of the energy fluxes in a radiant medium requires the solution of a system of coupled conservation equations including the integrodifferential equation of radiant energy conservation. The resulting complexity may be avoided when radiation transfer is small compared to the usual molecular transport processes. For high temperatures, however, it becomes necessary to study the interaction of these processes in order to solve this system. As a first step toward a better understanding of this type of problem, the present paper is concerned with the solution of the Couette flow in such a case. It is found that the effect of the "long-range" process of radiation is to smooth out the temperature

profiles and relieve the sharp temperature gradients at the cool wall. As a result, the application of this exact method yields a lower value of the total heat flux than calculated previously by approximate methods.

From authors' summary by S. Lampert, USA

6294. Goodman, T. R., Aerodynamic ablation of melting bodies, Proc. Third U. S. Nat. Congr. Appl. Mech., June 1958; Amer. Soc. Mech. Engrs., 1958, 735-745.

Under some simplifying assumptions the melting and ablation of a metal wall adjacent to a hot air flow is treated. The assumptions essentially restrict the theory to short times of interaction (neglect of change in flow and air shearing stress due to change of form of the wall) and relatively strong ablation (thin layer of melt). As an example the flat plate with constant heat input is treated. It is pointed out that in this and other cases similar solutions will exist. These cases can be reduced to ordinary differential equations which can be solved numerically.

A main feature of the theory is the occurence of a traveling wave in the melt at the start of the heat input. Qualitative agreement was obtained in experiments on the ablation of a water layer on a lucite plate by means of a sudden burst of gas flow.

L. J. F. Broer, Holland

6295. Glaser, H., Simplified calculation of the diffusion of water vapor through walls consisting of several layers, including the effect of water and ice formation, Part II (in German), *Kaltetechnik* **10,** 12, 386-390, Dec. 1958.

See AMR **12** (1959), Rev. 2062.

6296. Kovalenko, V. F., An experimental investigation of the vibration effect on heat transfer in the process of boiling (in Russian), *Teploenergetika* no. 2, 76-77, Feb. 1958.

6297. Sparrow, E. M., and Gregg, J. L., A theory of rotating condensation, *Trans. ASME* **81** C (*J. Heat Transfer*), 2, 113-120, May 1959.

An analysis is made for film condensation on a rotating disk situated in a large body of pure saturated vapor. The centrifugal field associated with the rotation sweeps the condensate outward along the disk surface, and gravity forces need not be involved. The problem is formulated as an exact solution of the complete Navier-Stokes and energy equations. Numerical solutions are obtained from Prandtl numbers between 0.003 and 100 and for $C_p \Delta T / h_{fg}$ in the range 0.0001 to 1.0. Results are given for the heat transfer, as well as for the condensate layer thickness, torque moment, and temperature and velocity profiles.

From authors' summary by T. R. Goodman, USA

6298. Szucs, L., Analytical examination of changes of state at material and heat transfer at constant liquid temperature (in Hungarian), *Energia es Atomtechnika* **11,** 3, 164-167, Mar. 1958.

6299. Knuth, E. L., Nonstationary phase changes involving a condensed phase and a saturated vapor, *Physics of Fluids* **2,** 1, 84-86, Jan.-Feb. 1959.

A theoretical analysis is presented for the heat transferred to (or from) a saturated vapor phase brought into contact with a semi-infinite condensed phase initially at a constant temperature. The heat flux is assumed to be due to the latent heat of evaporation or condensation. Nonstationary temperature distributions and evaporation or condensation rates are presented.

L. Lapidus, USA

6300. Rydstad, B., Influence of vibration upon the solidification of metals (in Swedish), *Tekn. Tidskr.* **89,** 11, 255-258, Mar. 1959.

6301. Gel'perin, I. I., and Rapoport, L. L., The hydraulic resistance of coiled heat exchangers (in Russian), *Trudi Gos. N.-i. i Proyektn. In-ta Azotn. Prom-sti* no. 3, 193-199, 1954; *Ref. Zh. Mekh.* no. 2, 1958, Rev. 1980.

It is demonstrated that calculation of the hydraulic resistance of a coil heat exchanger from expressions obtained for a comparatively widely-spaced bundle of tubes gives an exaggerated value of the hydraulic resistance. An empirical formula is developed for calculating the hydraulic resistance of a closely-spaced tube bundle such as a heat-exchanger coil. I. S. Simonov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6302. Hausenblas, H., The mean temperature difference in hairpin heat exchangers (in German), *Brennstoff-Warme-Kraft* **11,** 3, 114-116, Mar. 1959.

Paper develops the relation for the mean temperature difference in a two tube-side pass one shell-side pass heat exchanger with the usual assumptions of constant fluid properties and constant overall coefficient of heat transfer.

Such expressions have been available in American textbooks for some time, e.g. Kern, "Process heat transfer," McGraw Hill. Author gives full credit to American writers.

A useful chart is included relating the mean temperature difference for this type of heat exchanger to the logarithmic mean temperature difference. W. A. Wolfe, Canada

6303. Aleksandrova, N. D., The technique of plotting heat exchanger frequency characteristics by graphical method (in Russian), *Teploenergetika* no. 1, 70-74, 1958.

The complex exponent of the function which represents the ratio of the Laplace transforms of the inlet and outlet temperatures of a highly schematized heat exchanger is rendered in a graphical representation, as is usual for complex quantities.

This makes it possible to obtain the curves which represent the dynamic characteristics of the heat exchanger as functions of the frequency. The results are of interest in the problem of regulation of heat exchangers working under fast varying conditions.

Author claims that much time is saved if her method is used.

L. G. Hamburger, Roumania

6304. Tal, A. A., Approximate determination of dynamic properties of single-phase heat-exchangers (in Russian), *Teploenergetika* no. 10, 69-71, 1957.

Paper represents the simplification, by means of an approximate calculation, of the exact results obtained by author in a previous paper concerning the determination of the dynamic characteristics of single-phase heat exchangers.

L. G. Hamburger, Roumania

6305. Benzinger, T. H., On physical heat regulation and the sense of temperature in man, *Proc. Nat. Acad. Sci., Wash.* **45,** 4, 645-659, Apr. 1959.

6306. Soehngen, E. E., Interferometric studies on heat transfer (in English), 9th Congrès Intern. Mécan. Appl., Univ. Bruxelles, 1957; **4,** 475-485.

6307. Bingham, C. R., Temperature detectors, *Electronics* **32,** 28, p. 55, July 1959.

6308. Mejzlik, L., Determination of temperature in massive concrete structures considering the ambient temperature and the heat developed during setting. Parts I and II (in Czechoslovakian), *Stavebnicky Casopis* **6,** 1, 53-64, 1958; **6,** 2, 116-130, 1958.

6309. Smutek, R., Flow of fluid layers of different temperature (in English), *Rozpravy Československé Akad. Věd* **65,** 4, 44-49, 1955.

6310. Gasparovic, N., Mechanical work from the heat of the exhaust of gas turbines (in German), *Öst. Ingenieur Z.* **1**, 12, 520–523, Dec. 1958.

Combustion

(See also Revs. 6189, 6363)

6311. Robb, J. D., Hill, E. L., Newman, M. M., and Stahmann, J. R., Lightning hazards to aircraft fuel tanks, *NACA TN* 4326, 58 pp., Sept. 1958.

Paper presents a detailed study of the lightning hazards to aircraft fuel tanks and of the effects occurring in such events. A theoretical part concerns the heat flow in a plate due to the lightning stroke, assumed to be equivalent (when punctures of fuel-tank wall do not occur) to an instantaneously introduced heat in a small block of the plate. Solution is obtained by means of series developments. Experimental comparisons give a reasonable agreement with the theory. The effect of an airstream on the heat flow to the inner surface of the plate is also experimentally investigated.

Fuel-tank explosion studies were made experimentally, using electric discharges, for determining the tank wall puncturing possibilities, as well as metal erosion from lightning discharges. The investigations were carried out both on scale models in a special wind tunnel and on aircraft. An analysis of statistical data including more than 400 cases of lightnings to aircrafts is also given, by pointing out the altitude influence on the lightning hazard as well as the most probable aircraft parts to be damaged by lightning discharges.

Authors conclude that there exists the probability of fuel-tank explosion especially when wall punctures occur. In other events (90% of the cases), the fuel-tank wall temperatures increase only for brief periods, insufficient probably to cause explosions, especially of aviation gasoline. Besides, only 10% of the strokes take place in wings, which are the principal fuel storage areas. The fuel-tank wall thickness for avoiding punctures is also indicated (0.081 inch), but authors ascertain that, at any rate, some protection systems must be employed.

V. N. Constantinescu, Roumania

6312. Rapp eneau, J., and Grassin, H., Study of flames stabilized on rotational bodies at high subsonic speeds. Thermochemical structure of the nucleus of stabilization (in French), *ONERA NT* 41, 44 pp., 1958.

6313. Nagao, F., Kobayakawa, T., and Adachi, F., Stationary flame front in a swirl combustion chamber, *Bull. JSME* **1**, 2, 150–155, June 1958.

Paper presents the first published photographs of combustion in a "Texaco Combustion Process"-type engine. Reviewer believes the theoretical model which is analyzed is too simple to explain the phenomena described in the principal reference. Authors' suggestion of continuous ignition is interesting.

J. C. Livengood, USA

6314. Lorell, J., Wise, H., and Carr, R. E., Steady-state burning of a liquid droplet. Part I, Monopropellant flame, Part II, Bipropellant flame, *J. Chem. Phys.* **23**, 10, 1928–1932, Oct. 1955; **25**, 2, 325–331, Aug. 1956.

6315. Blinov, V. I., and Khudiakov, G. N., Certain laws governing diffusive burning of liquids (in Russian), *Dokladi Akad. Nauk SSSR (N.S.)* **113**, 5, 1094–1098, 1957.

This paper on the natural burning of liquid petroleum products in pans is especially significant because of the wide range of pan size covered, sufficient to block out clearly the various burning regimes and to indicate, to investigators of fire modeling, the hazards associated with drawing conclusions from studies of too limited size range.

Gasoline, tractor kerosene, diesel oil, and solar oil (and, to a limited extent, household kerosene and transformer oil) were burned in cylindrical pans (depth not indicated) of diameters 0.37 cm to 22.9 *meters*. Liquid burning rates and flame heights were measured, and visual and photographic observations of the flames were recorded.

The photographs indicate that, as the pan diameter increases, the flame structure, for any of the fuels, changes from a conical steady flame (1.1-cm pans) to a pulsating-tip flame of maximum frequency about 18–20 cycles per second (3-cm pans). Further increase in pan diameter reduces the pulsations, but the unstable portion of the flame shifts downward until, for a 15-cm pan, the entire flame is changing continuously in structure everywhere; and with 1.3-meter pans the random turbulent motion is fully established.

1. The burning velocity-pan diameter relation has the same general structure for all the oils. It first decreases with increasing pan diameter, with an almost constant product of the two. This is the laminar flow regime, with Re less than about 20 (based on properties of the non-burning fuel vapor). With further increase in pan diameter the velocity decrease decreases, changes sign, rises rapidly in the range of Re from 20 to 200, and finally levels off again at a pan diameter about 1 meter or a Reynolds number of about 500. Above that value the burning is turbulent and the burning velocity is substantially uninfluenced by pan diameter or fuel type.

A continuous decrease in the flame length δ/pan diameter d ratio persists out to the turbulent regime where it becomes constant for the one fuel adequately studied (gasoline). In the laminar regime a constant negative slope corresponds to the relation $(\delta/d) \propto d^{-n}$. In the same regime the burning-rate curves may be expressed by the relation $v \propto d^{-m}$. These relations may be combined to give $(v)(d/\delta) \propto d^{n-m}$, or

$$vd^2/\delta \propto d^{n+1-m}.$$

In the turbulent regime the flame length/pan diameter ratio is constant at high Reynolds number. This is also analogous to findings from studies of turbulent flames of fuel jets, where the flame length-diameter ratio is found to be independent of Reynolds number. The result is a consequence of air-fuel mixing by turbulent rather than by molecular transport.

The burning rate keeps pace with the fuel vaporization rate, which is heat transfer-controlled. The rate of heating q is the sum of q_1, q_2, q_3 representing the transfer rates from the pan rim, by convection, and by flame radiation, respectively. The authors call attention to the fact that in large reservoirs q_1 and q_2 are smaller than q_3 and that in consequence the constancy of burning velocity v for turbulent combustion indicates that the irradiation rate per unit of the liquid surface is independent of reservoir diameter. It is tempting to add, to this qualitative treatment of the authors, a simplified semiquantitative analysis. Let

$$q_1 = k_1\pi d(T_F - T_B);\ q_2 = U(\pi d^2/4)(T_F - T_B);\ q_3 = (\pi d^2/4)\sigma F(T_{F^4} - T_{B^4})(1 - e^{-\kappa d})$$

where U = convection coefficient; F geometrical view-factor that the liquid has of the flame; κ = Beer's law extinction coefficient of the flame to allow for increasing opacity with thickness. Then the vaporization rate per unit of surface is given by

$$\frac{q}{\pi d_3/4} = \frac{k_1(T_F - T_B)}{d} + U(T_F - T_B) + \sigma F(T_{F^4} - T_{B^4})(1 - e^{-\kappa d})$$

Even with k_1, U, F, T_F and κ assumed constant (which they are not), this relation has a form which can be fitted to the burning-rate curves. At small d's the first term on the right will be large and cause the burning rate to be high. At large d's the term will

have disappeared completely, the second will be constant, and the third and dominant term will be constant because κd is so large. At intermediate d's the third term will be low because of the thinness of the flame, but the pan will be too large for the first term to be significant; hence a minimum burning rate. Calculations based on the gasoline results indicate that on the basis of $U = 1$ (English units), $F = \frac{1}{4}$, and d large enough to make the flame opaque, the burning rate corresponds to radiation and convection from a flame at about 1600°F or 1100°K. H. C. Hottel, USA

Courtesy Fire Research Abstracts and Reviews

6316. Zinzen, A., On the calculation of slagging furnaces (in German), *Brennstoff-Warme-Kraft* **11,** 3, 117–119, Mar. 1959.

The theory of liquid ash combustion is based on three fundamental facts: first, the heat transfer by radiation between the flame and the wall; second, the heat flow through the combustion chamber wall to the boiler heating surfaces; and third, the difference between the theoretical combustion temperature and the actual flame temperature. A diagram is given which shows these relations and simplifies the calculation of the magnitudes for a liquid ash combustion chamber with given dimensions, and also the calculation of the dimensions for a chamber for a different set of combustion conditions. Author states that the paper is an addition to the chapter on Heat Transfer in Combustion Chambers in his book on boilers, but the paper is only three pages and is a very abbreviated treatment of the subject. The diagram, however, is large enough to be used for numerical calculations and will obviously save the user a great deal of work.

M. W. Thring, England

6317. Kogarko, S. M., Investigation of the pressure at the end of a tube in connection with rapid nonstationary combustion, *Soviet Phys.-Tech. Phys.* **3,** 9, 1875–1879, Apr. 1959. (Translation of *Zh. Tekh. Fiz., Akad. Nauk SSSR* **28,** 9, 2041–2045, Sept. 1958 by Amer. Inst. Phys., Inc., New York, N.Y.)

Hydrocarbon-air and hydrogen-air mixtures no longer detonate as fuel ratio is decreased below a certain value. Instead, rapid nonstationary combustion takes place causing pressures at the end of tube up to 6.5 times greater than calculated for a reflected detonation wave in same mixture. Similar behavior occurs in stoichiometric methane-oxygen plus nitrogen mixtures when fraction of diluent is increased. Continuously changing flame velocities were also observed whereas steady-state detonation propagates at constant velocity.

Average pressures at the end of a pipe due to combustion of 0.04 propane-0.96 air mixtures were measured using a ballistic technique which is described in another paper, *Zh. Tekh. Fiz., Akad. Nauk SSSR* **27,** 4, p. 833, 1957. Maximum average pressure observed was 470 kg/cm² when initial pressure was 1 kg/cm².

A shock wave, which is too weak to ignite the mixture, propagates due to combustion. Reflection of the wave at the end of tube compresses and heats the gas sufficiently to cause ignition. Local high pressures develop. This investigation may explain previously reported abnormal high pressures, e.g., *J. Appl. Phys.* **29,** 9, 1381–1382, Sept. 1958. A. E. Fuhs, USA

6318. Gross, R. A., Research on supersonic combustion, *ARS J.* **29,** 1, 63–64 (Technical Notes), Jan. 1959.

6319. Winkler, Eva M., and Cha, M. H., Experimental investigations of the effect of heat transfer on hypersonic turbulent boundary-layer skin friction, *J. Aero/Space Sci.* **26,** 2, 123–124 (Readers' Forum), Feb. 1959.

6320. Potter, A. E., Jr., and Butler, J. N., A novel combustion measurement based on the extinguishment of diffusion flames, *ARS J.* **29,** 1, 54–56 (Technical Notes), Jan. 1959.

Prime Movers and Propulsion Devices

(See Rev. 6310)

Magneto-fluid-dynamics

6321. Bleviss, Z. O., The structure of a steady magneto-hydrodynamic switch-on shock wave, Heat Transf. and Fluid Mech. Inst., Univ. Calif., Los Angeles, Calif., June 1959, 27–40.

This paper solves the problem of structure of magnetohydrodynamic shocks that are normal to incident but not emergent flow, making continuum assumptions and taking a perfect gas with a scalar conductivity low enough for only the magnetic diffusivity to operate. Analysis and results are closely analogous to the well-known case of a shock without normal field component. The broad magnetic transition is terminated by a simple gas-dynamic shock if the emergent normal Mach number is subsonic. The validity of the assumptions is considered briefly. The style is admirably terse but lucid. J. A. Shercliff, England

6322. Yavorskaya Shapshal, I. M., Investigation of some irregular motions of a gravitating gas in the presence of shock waves of detonation, of the magnetic field (in Russian), Avtoref. Diss. Kand. Fiz.-matem. Nauk, MGU, Moscow, 1957; *Ref. Zh. Mekh.* no. 3, 1958, Rev. 3044.

6323. Napolitano, L. G., Discontinuity surfaces in magneto-fluid-dynamics, AFOSR TN 59–67 (Polyt. Inst. Brooklyn, Dept. Aero. Engng. Appl. Mech. Rep. 503; ASTIA AD 209 842), 39 pp., Dec. 1958.

This report is concerned with the macroscopic study of magneto-fluid-dynamic discontinuities for negligible relativistics effects. Jump conditions relating the end states on the two sides of discontinuity surfaces of arbitrary geometry are derived for both the steady and unsteady cases. Applications are presented in connection with (a) the magneto-fluid-dynamic counterpart of the Truesdell-Lighthill-Hayes problem of determining the vorticity jump across a shock and (b) the existence of magneto-fluid-dynamic slip and/or contact surfaces.

From author's summary

6324. Davis, L., Lust, R., and Schluter, A., The structure of hydromagnetic shock waves. Part I: Nonlinear hydromagnetic waves in a cold plasma (in English), *Z. Naturforsch.* **13a,** 11, 916–936, Nov. 1958.

The waves in a cold (no thermal motions) quasi-neutral gas consisting of ions and electrons are treated neglecting collisions but not neglecting the inertial effects associated with the electric current. Provided the particle trajectories do not make loops, the nonlinear equations for infinite plane compressional waves traveling perpendicular to a uniform magnetic field with unchanging form and speed are reduced to a single second-order ordinary differential equation in the field strength and solved exactly. The solutions can be expressed in terms of elliptic functions. Graphs give the properties of the waves. Both wave trains and solitary waves are found, all solutions being symmetrical about maxima and minima in the field strength. The wavelengths are of the order of the gyroradius. The velocities range from zero to twice the Alfvén velocity, higher velocities leading to looped trajectories. The relation of these waves to hydromagnetic shock waves in low density plasmas is considered and it is concluded that the entire shock will have a thickness determined by the product of mean time between collisions and the gas velocity with respect to the shock front. Two analogs of the Rankine-Hugoniot conditions are given.

From authors' summary by G. Sestini, Italy

6325. Chuan, R. L., and Smetana, F. O., Experiments on a radio frequency discharge plasma in supersonic flow, Heat Transf. and Fluid Mech. Inst., Univ. Calif., Los Angeles, Calif., June 1959, 236–243.

Experiments have been conducted with the view toward developing a radio frequency discharge for use as a heat source in low density, supersonic flows. Early studies had indicated that this heating technique is attended by several little-studied problems, and it was the purpose of these experiments to provide additional data on these phenomena.

Among the problems studied was that of providing a suitable electrode configuration which permits matching of the generator to the load and which provides for minimum stray radiation and high density power input. Also studied was the problem of determining an optimum length of time or distance during which the recombination processes would be sufficiently near completion and for which the physical length would not be unreasonable or the heat transfer to the walls self-defeating.

As a means for permitting the decay processes to reach equilibrium, control of diffusion of free electrons with its subsequent heat transfer to the wall was also studied.

The results of these studies to date and some preliminary interpretations of their significance are given.

From authors' summary

6326. Ludford, G. S. S., The propagation of small disturbances in hydromagnetics, *J. Fluid Mech.* **5,** 3, 387–400, Apr. 1959.

Paper deals with the propagation of small initial disturbances in a conducting gas under the influence of a uniform external magnetic field. The starting point is the usual system of equations of magneto-gasdynamics, with the coefficients μ (permeability), ε (dielectric constant) and σ (conductivity) being constant and the charge density different from zero. Introducing a deviation from a given uniform state and neglecting squares, author obtains a system of nine first-order linear partial differential equations. The first problem solved is that of plane waves, with the initial set splitting into two sets, leading to a quartic and a quintic for the frequency. From the roots, three give pure decay, and the remaining six three possible modes of propagation of sinusoidal disturbances (one is an Alfvén wave). As the next item author shows that the general linearized equations can be split into two sets of four and five, which lead to partial differential equations of the order two and four, respectively.

The boundary-value problem of standing waves in the fluid confined in a rectangular box made of a perfectly conducting material is discussed next. Three types of waves appear: those corresponding to an infinity of frequencies associated with the Alfvén velocity, and two others distinguished by their symmetry properties. The distributions of frequencies are sketched for the two extreme cases of very weak and very strong external fields. The limiting forms of the waves for the two extreme cases are also considered; a discussion of the general initial-value problem and of the determination of Fourier coefficients referring to the standing waves closes the paper. M. Z. v. Krzywoblocki, USA

6327. Yih, C.-S., Ring vortices generated electromagnetically, *J. Fluid Mech.* **5,** 3, 436–444, Apr. 1959.

If an electric current of uniform density j_0 is passed axially through a stationary fluid between concentric cylinders of radii r_1 and r_2 ($> r_1$), the fluid is stable to axisymmetric disturbances only if damping provided by viscosity and electrical resistivity is sufficiently large. It is shown that the fluid may also be stabilized by passing a line current J along the axis, sufficient condition for stability being $J \leqslant -\pi j_0 (r_2^2 - r_1^2)$ or $\geqslant J\pi j_0 r_1^2$. The values of J needed to stabilize the fluid for non-zero viscosity and finite conductivity are calculate for the case $r_2 - r_1 \ll r_1$. In this latter case, the ring vortices which exist under conditions of neutral stability are exactly the same as those for flow between rotating cylinders if J and j_0 have the same sign and if J is not very small compared with $\pi j_0 r^2$.

From author's summary by R. Nardini, Italy

6328. Gordeev, G. V., and Gubanov, A. I., Acceleration of a plasma in a magnetic field, *Soviet Phys.-Tech. Phys.* **3,** 9, 1880–1887, Apr. 1959. (Translation of *Zh. Tekh. Fiz., Akad. Nauk SSSR* **28,** 9, 2046–2054, Sept. 1958 by Amer. Inst. Phys., Inc., New York, N. Y.)

The acceleration of a plasma between two infinite coaxial cylindrical electrodes due to an external axial magnetic field is considered. Authors compute the stationary plasma flow taking account of friction with the electrode, the dependence of flow velocity on magnetic flux and the radii of the electrodes, and the energy required to maintain the flow. The calculations show that it is possible to achieve supersonic plasma flow velocities with parameters which are realizable in practice.

From authors' summary by A. E. Fuhs, USA

6329. Patrick, R. M., and Brogan, T. R., One-dimensional flow of an ionized gas through a magnetic field, *J. Fluid Mech.* **5,** 2, 289–309, Feb. 1959.

The paper describes two types of experiments on the flow of partially ionized argon through a magnetic field. The ionization is produced by strong shocks in a shock tube. One type of experiment is called the "annular" experiment in which the flow area is essentially constant; the second type of experiment, called the "end" experiment, has a flow area which varies linearly in the flow direction. The end experiment had a more uniform magnetic field and had a longer period of steady flow than the annular experiment.

The theoretical discussion of the experimental results is based on the one-dimensional flow equation of Shapiro and Hawthorne [*J. Appl. Mech.* **14,** p. 317, 1947]. The magnetic effects through magnetic body forces on supersonic (and subsonic) flow for the two types of experiments are worked out by this theory and reasonably good agreement with the observations is found. It is shown that sufficiently strong magnetic fields produce choking of the flow. Observations of the electric current density for both types of experiments show that the electrical conductivity is less than the scalar value. This reduction in conductivity is ascribed to two effects of which the first is the Hall effect and the second is an ion slip effect, i.e., an effect which is produced by a difference between the ion velocity relative to the magnetic field and the neutral particle velocity relative to the field.

M. S. Plesset, USA

6330. Smirnov, A. G., Free thermal convection of mercury in a closed circular tube in a transverse magnetic field, *Soviet Phys.-Tech. Phys.* **3,** 7, 1429–1434, Feb. 1959. (Translation of *Zh. Tekh. Fiz., Akad. Nauk SSSR* **28,** 7, 1549–1555, July 1958 by Amer. Inst. Phys., Inc., New York, N. Y.)

An experimental study is made of the effect of a homogeneous magnetic field (from 70 to 7000 gauss) on the free convective motion of mercury in a closed circular glass tube inclined at 10° with the vertical under certain thermal conditions.

Two cases are studied: (A) the direction of the magnetic field is perpendicular to the plane of separation of the rising and descending currents in the tube, and (B) the direction of the magnetic field is parallel to this plane. From author's summary

6331. Weibel, E. S., On the confinement of a plasma by magnetostatic fields, *Physics of Fluids* **2,** 1, 52–56, Jan.–Feb. 1959.

Two results are given. First proves that a plasma under thermodynamic equilibrium is not affected by magnetostatic fields. Second gives one stationary solution for the linear pinch for the collision-free case which is non-Maxwellian.

H. Yoshihara, USA

6332. Granovskii, V. P., Riumina, K. P., Savoskin, V. I., and Timofeeva, G. G., Observations of the pinch effect at decreasing currents, *Soviet Phys.-JETP* **8**, 1, 33–36, Jan. 1959. (Translation of *Zh. Eksp. Teor. Fiz., Akad. Nauk SSSR* **35**, 45–50, July, 1958 by Amer. Inst. Phys., Inc., New York, N. Y.)

Image-converter photographs have been taken of transient states of pulsed discharges in H_2 and Hg at pressures of 10^{-2} to 10^{-3} mm Hg. The peak pulse currents were 1.3 to 5.5 kiloamperes and the pulses were 300 μsec long. Electrodynamic deformations (contraction and kinking) are observed at negative values of di/dt. It is found that these deformation effects first disappear (as manifested by the straightening and expansion of the column) at points of high local gas density (anode or cathode, depending on the experimental conditions). From authors' summary

6333. Meyer, F., and Schmidt, H. U., Toruslike configurations of a plasma in equilibrium with an exterior magnetic field without azimuthal current (in German), *Z. Naturforsch.* **13a**, 12, 1005–1015, Dec. 1958.

The authors attack the problem of the existence of toruslike configurations of a plasma in an equilibrium with an exterior magnetic field. The starting point is the Maxwell equations with the pressure of the gaseous medium being constant over the entire external surface of the torus. As the first problem, authors solve the following question: Do toruslike surfaces exist with meridional, closed and equally distributed current lines? To answer this, authors consider the geometry of the toruslike surface and establish a differential equation based on the equation of the length of an arc. The first answer is that there cannot exist a torus configuration with plane, closed current lines, whose planes pass through the z-axis. To find the possible configurations, they solve the equation in question by means of characteristics which are identical with the lines of the magnetic field. The current lines can be closed plane curves but their planes cannot pass through one and the same axis. The disturbances in the distribution of the initial values propagate always along characteristics. The plasma cross section must have maxima and minima. Authors construct a few possible toruslike configurations, show their azimuthal and meridional cross sections and prove that they always must possess an azimuthal component of the current. Finally they constructed a paper model of a torus, whose picture shows many interesting details. This is a nice contribution to the field in question. M. Z. v. Krzywoblocki, USA

6334. Anderson, O. A., Furth, H. P., Stone, J. M., and Wright, R. E., Inverse pinch effect, *Physics of Fluids* **1**, 6, 489–494, Nov./Dec. 1958.

An electric current passing along a conducting rod and returning through ionized gas surrounding the rod forms a magnetic field pushing the plasma outward, leaving behind a cylindrical vacuum region. This effect appears to be more amenable to experimental studies than is the pinch effect.

Displacement and thickness of the plasma front were measured optically and magnetically. At low mass densities, the observed front thickness justifies use of the "snow-plow" model, and the front velocity is described to good approximation by analytical results based on this model. At higher densities, it appears that the magnetic field is diffused significantly into the cold plasma.

Authors' suggestion that these studies of the inverse dynamic pinch be followed by studies of the inverse stabilized pinch seems to merit consideration. E. L. Knuth, USA

6335. Simon, A., Ignition of a thermonuclear plasma by high-energy injection, *Physics of Fluids* **1**, 6, 495–500, Nov./Dec. 1958.

Some prototypes of thermonuclear machines use ions accelerated to high energies and then injected into a magnetic container ("mirror geometry"). The terminal ion density is reduced by charge exchange with residual neutral molecules, converting the fast ion into a fast neutral which escapes the magnetic container and leaves only a slow ion behind. Author shows that for sufficiently large input currents a condition designated as "burnout" can be achieved in which neutrals entering the magnetic containment region are ionized and removed through the leakage of the container more rapidly than they can enter. Approximate equations for these conditions are numerically integrated and it is found that the density of the neutral gas background may be reduced by orders of magnitude. W. M. Elsasser, USA

6336. Auer, P. L., Hurwitz, H., Jr., and Miller, R. D., Collective oscillations in a cold plasma, *Physics of Fluids* **1**, 6, 501–514, Nov./Dec. 1958.

The waves considered here are linearized displacements in a plasma in which there exists a strong magnetic field, assumed as homogeneous in the special applications. Only one kind of positive ions is admitted. The temperature motions of the particles as well as any collisions are neglected, so that the medium is non-dissipative. Starting from a characteristic equation (dispersion relation) given for this case by Astrõm in 1950, authors discuss extensively the nature of the various modes that can arise. This discussion is first carried on in terms of potentials and the field quantities derived from them, and then in terms of particle orbits. It is found that when the Alfvén dielectric constant, $4\pi n (M + m) c^2 B_0^2$ becomes comparable in magnitude to the ion-to-electron mass ratio, plasma space charges may become important in the oscillations. W. M. Elsasser, USA

6337. Hain, K., and Lust, R., Stability of axially symmetrical plasma configuration in volume flow (in German), *Z. Naturforsch.* **13a**, 11, 936–940, Nov. 1958.

Small perturbation techniques are used to investigate plasma configurations containing currents inside the plasma and possessing cylindrical symmetry. The problem is reduced to an eigenvalue problem. Considering a special configuration with a relatively strong current along the axis, it is shown that this configuration is unstable for long wavelength perturbations.

D. Ter Haar, England

6338. Golitsyn, G. S., Plane problems in magnetohydrodynamics, *Soviet Phys.-JETP* **7**, 3, 473–477, Sept. 1958. (Translation of *Zh. Eksp. Teor. Fiz.* **34**, 3, 688–693, Mar. 1958 by Amer. Inst. Phys., Inc., New York, N. Y.).

Conditions for the potential flow of an inviscid fluid with infinite electrical conductivity are set forth briefly. Attention is then turned to motion in a plane perpendicular to the magnetic field; a nonstationary generalization of magnetohydrodynamic Prandtl-Mayer motion is introduced; and finally the magnetohydrodynamic Prandtl-Mayer problem is discussed in some detail, with a presentation of various results. C. M. Crain, USA

6339. Veress, G., Design and operation of electromagnetic pumps, Parts I, II (in Hungarian), *Energia es Atomtechnika* **11**, 7/8, 474–484, July/Aug. 1958; **11**, 9/10, 633–639, Sept./Oct. 1958.

Author reviews the governing equations in their elementary forms both for the electromagnetic body forces and for hydraulics in pipes. In treating the design problem of pumps for liquid metals he uses the analogy with electrical engineering (both d c motor and induction motor analogies). L. S. G. Kovasznay, USA

Aeroelasticity

(See also Revs. 6220, 6229, 6230)

6340. Stahle, C. V., Transonic effects on T-tail flutter, The Martin Co., Res. Memo. 24, 50 pp., Feb. 1959.

This report presents experimental data on the antisymmetric flutter characteristics and subcritical behavior of T-tails in the transonic range, and it describes a spectrum analysis technique for determining the subcritical behavior from the model response to tunnel turbulence. An extension of the low-speed tests reported in "Flutter of T-Tails with Dihedral," this program investigates the transonic effects of stabilizer dihedral and hull stiffness on the flutter characteristics of T-tails.

A series of ten dynamically similar models having stabilizer dihedral angles of 0°, 15°, or 30° were tested from Mach 0.5 to 1.15. The flutter mode of all the models tested was dominated by fin bending and hull lateral bending motion, and the flutter condition was characterized by the convergence of the frequencies of the first and second modes. The results indicate that stabilizer dihedral lowers the flutter boundary, as defined by the altitude-stiffness parameter, throughout the transonic range. The flutter boundary for the 15° dihedral configuration has a "transonic dip" at Mach 0.8 with a 10% reduction in the altitude-stiffness parameter. However, the region of minimum stability appears to occur at or above Mach 1.05 for the 0° dihedral configuration and near Mach 0.6 for the 30° dihedral configuration. Limited results on the effect of hull stiffness indicate that a reduction on hull stiffness of 40% lowers the critical flutter speed of the 30° dihedral configuration by 8%.

A gull stabilizer configuration with 15° positive dihedral at the root section and 15° negative dihedral at the tip section was tested. The results indicate that the flutter point of the gull configuration is 15% higher than that of the 15° dihedral models, but it is lower than the flutter boundary of the models without dihedral.

The subcritical behavior of the models was determined from spectrum analysis of the model response to tunnel turbulence. The response spectra were obtained from analysis of magnetic tape records and were combined with turbulence data to provide damping trends. The subcritical data indicate that the third mode, predominately fin torsion, is lowly damped and that the flutter mode is generally associated with the second mode, predominately fin bending. For the configurations tested, flutter could be predicted from the subcritical behavior by the convergence of frequencies of the first and second modes, and by the trend to zero of modal damping and of the reciprocal of the amplitude of the flutter mode.

An automatic tunnel shut-off device, designed to prevent model destruction when flutter occurred, was used in these tests. Although it failed to accomplish its primary purpose, in that flutter generally resulted in model destruction, the device did provide an indication of the approach to flutter.

From author's summary

6341. Tyler, E. F., The oscillating inboard flap at supersonic speeds, *J. Aero/Space Sci.* **26,** 1, 56–58 (Readers' Forum), Jan. 1959.

Extension of reviewer's analysis for outboard control surface [*J. Aero. Sci.* **14,** 6, 351–358, June, 1947].

J. W. Miles, USA

6342. Poppleton, E. D., and Ram, G. S., Approximate calculation of the pressure distribution on a rectangular wing oscillating in incompressible flow, Univ. Toronto Inst. Aerophys. Rep. 56, 43 pp., Sept. 1958.

Paper develops an approximate method for the calculation of aerodynamic forces on oscillating rectangular wings in incompressible flow. The procedure is similar to that used by Küchemann for the steady case [Aero. Res. Counc. Lond. Rep. Mem. 2935, Aug. 1952] and the final results agree with known theory for both large and small aspect ratio. Agreement with experimental results is reasonably good and computational labor very much less than that involved in using the usual lifting surface theories.

W. S. Hemp, England

6343. Miles, J. W., Supersonic flutter of a cylindrical shell, Part II, *J. Aero. Sci.* **25,** 5, 312–316, May 1958.

The theory of Part I [AMR **11** (1958), Rev. 256] is applied to pressurized shells filled with either gas or liquid. The flutter speeds and negative damping ratios are calculated; the latter also are presented in graphical form.

From author's summary

6344. Sewall, J. L., An experimental and theoretical study of the effect of fuel on pitching-translation flutter, *NACA TN* 4166, 42 pp., Dec. 1957.

Analytical flutter studies were made for 2 two-dimensional fuel-loaded wing models, and the results are compared with experimental results for bending-to-torsion frequency ratios near 1. One of the models was made so that water, simulating fuel, could be carried internally in three compartments separated by sealed spanwise partitions. The flutter speeds of this model for all fuel loads were highest for the compartmental-emptying sequence from front to rear. In the other model, fluid was carried externally in a pylon-mounted fuel tank without baffles. Good agreement between theory and experiment was obtained for both models.

From author's summary

6345. Abramson, H. N., and Beckmann, P. A., Jr., Investigation of a method for the measurement of subsonic oscillatory aerodynamic influence coefficients, *WADC TR* 57-736 (Southwest Research Inst.; ASTIA AD 142-201), 68 pp., Dec. 1957.

Object was to investigate feasibility of wind-tunnel measurement of subsonic oscillatory aerodynamic influence coefficients in form of pressure distribution casued by unit downwash element in element of wing area. Downwash unit was simulated by doublet combination of opposite orifices connected to blowing-and-sucking ducts in wing. Measured pressures refer to 4 × 4 chordwise and spanwise positions. Results are considered satisfactory by authors, but reviewer tends to conclude that reliable set of coefficients suitable for applications is still a long way off.

J. H. Greidanus, Holland

6346. Arnold, L., Aeroelastic effects on dynamic behavior of aircraft (in English), C. R. Journées Internationales de Sciences Aéronautiques, Paris, May 27–29, 1957; Paris, ONERA, Part 2, 69–81.

6347. Collar, A. R., Aeroelasticity—retrospect and prospect (Second Lanchester Memorial Lecture), *J. Roy. Aero. Soc.* **63,** 577, 1–15, Jan. 1959.

Aeronautics

(See also Revs. 5870, 6220)

6348. Nicolo, G. B., Performance characteristics of an aircraft with jet and aerodynamic lift (in Italian), *Aerotecnica* **38,** 5, 269–284, Oct. 1958.

A short introduction shows the advantage of providing aircrafts with both jet and aerodynamic lift outside of a definite field of speed and altitude. After that author investigates the best coordination between the thrust angle and the angle of attack in order to get the following performances: minimum thrust, maximum range, max and minimum speed, max angle of climb.

The work includes some considerations about the existence of a maximum of four different possible conditions of flight with the same lift-drag ratio, thrust and slope.

The investigation ends with a basic analysis of the best correspondence between the thrust angle and the angle of attack during the take-off run.

As a conclusion author emphasizes that the best thrust angle to be adopted in every particular case is a function of the angle of attack, so that the determination of the two angles is reduced to the choice of the angle of attack only, as in the conventional airplane. From author's summary

6349. Gunter, S., The loss of energy due to steady flight along a curved path (in German), *Z. Flugwiss.* **6**, 1, 10–15, Jan. 1958.

The loss of energy due to steady flight along a curved path is discussed and equations are developed expressing the loss in range due to steady curves for four important flight programs. In two of the cases considered, the increase in thrust required to maintain steady flight along a curved path is given. The four nonsteady curves in the case when the thrust equals the drag in straight and level flight, and when the thrust is not increased at the beginning of the curved path, are calculated for two representative engine characteristics of thrust and speed and two values of QF/G. From author's summary

6350. Smiley, R. F., Correlation, evaluation, and extension of linearized theories for tire motion and wheel shimmy, *NACA Rep.* 1299, 48 pp., 1957.

See AMR **9** (1956), Rev. 3855.

6351. Milwitzky, B., Study of taxiing problems associated with runway roughness, *NASA Memo* 2-21-59L, 12 pp., Mar. 1959.

This paper briefly summarizes available statistical data on airplane taxi operations, examines the profiles and power spectra of four selected runways and taxiways covering a wide range of surface roughness, considers (on the basis of theoretical and experimental results) the loads resulting from taxiing on such runways over a range of speeds and, by synthesis of the aforementioned results, proposes new criteria for runway and taxiway smoothness which are applicable to new construction and may also be used as a guide for determining when repairs are necessary.

From author's summary

6352. Person, P., Semi-articulated bogie under-carriage landing performance, *Aircr. Engng.* **31**, 359, 2–5, Jan. 1959.

6353. Schwartzberg, M., Blown flap system for STOL performance—weight considerations, *Aero/Space Engng.* **18**, 3, 48–52, Mar. 1959.

The weight of a representative transport aircraft utilizing a blown flap installation to attain STOL performance is compared with that of an aircraft of similar performance having an unblown flap and a larger wing. The former is shown to have the larger payload capacity for equal gross weights when the design stall speed is less than 40 knots. Some design conditions most favorable for the blown flap installation are indicated in the discussion.

From author's summary

6354. Sadoff, M., Pitch-up problem—a criterion and method of evaluation, *NASA Memo* 3-7-59A, 14 pp., Feb. 1959.

A method is described for predicting the probable relative severity of pitch-up of a new airplane design prior to initial flight tests. An illustrative example is presented which demonstrates the use of this procedure for evaluating the pitch-up behavior of a large, relatively flexible airplane. The wing and tail loads likely to be encountered in pitch-up maneuvers are considered.

From author's summary

Astronautics

6355. Zwicky, F., Is Newton's law of gravitation really universal? *Astronautics* **4**, 1, 18–19, 74–76, Jan. 1959.

6356. Graham, E. W., Optimum trajectories in uniform and "almost uniform" gravitational fields, Douglas Aircr. Co. Rep. SM-23430, 30 pp., Feb. 1959.

Problems involving the transfer of a rocket vehicle from one point to another with minimum fuel expenditure are considered. The rocket vehicle is assumed to operate in a gravitational field without atmospheric resistance. The transfer time and the terminal velocity vectors are specified. From author's summary

6357. Ehricke, K., Interplanetary probes: three problems, *Astronautics* **4**, 1, 20–22, 42–46, Jan. 1959.

6358. Fernandez, M., An introduction to space navigation, *Astronautics* **4**, 1, 23–25, 76, Jan. 1959.

6359. Rider, L., Characteristic velocity for changing the inclination of a circular orbit to the Equator, *ARS J.* **29**, 1, 48–49 (Technical Notes), Jan. 1959.

6360. Cole, D. M., and Marrese, M. A., Optimization of rockets for maximum payload energy, *ARS J.* **29**, 1, 71–73 (Technical Notes), Jan. 1959.

6361. Murphy, C. H., Prediction of the motion of missiles acted on by non-linear forces and moments, BRL, Aberdeen Prov. Gr. Rep. no. 995, 79 pp., Oct. 1956.

6362. Jansson, J.-E., Influence of essential quantities on end launching condition (in Finnish), Svenska Tekniska Vetenskapsakademien i Finland, Acta, Vol. 17, 175 pp., 1955.

Ballistics, Explosions

6363. Kogarko, S. M., Detonation of methane-air mixtures and the detonation limits of hydrocarbon-air mixtures in a large-diameter pipe, *Soviet Phys.-Tech. Phys.* **3**, 9, 1904–1916, Apr. 1959. (Translation of *Zh. Tekh. Fiz., Akad. Nauk SSSR* **28**, 9, 2072–2083, Sept. 1958 by Amer. Inst. Phys., Inc., New York, N. Y.)

It has been shown experimentally that methane-air mixtures are capable of detonating in a tube of very large diameter (305 mm) within a wide range of variation of the methane concentration in the mixture. The detonation limits for a specified tube diameter are: (a) lower limit 6.3% CH_4 in air; (b) upper limit 13.5% CH_4 in air.

It has been established that (a) methane-air mixtures, assuming any content of methane in the mixture (within the ignition limits), cannot detonate in a pipe of small diameter (20 mm), even in that case when a very powerful shock wave is employed for initiation, where this is formed upon explosion of the mixture in a no. 8 capsule-detonator; (b) a detonation wave propagated in the stationary regime through a methane-air mixture in a tube of large diameter disintegrates upon passing into the same mixture contained in a tube of smaller diameter (20 mm), where the small tube is joined in parallel or series with the tube of large diameter.

It has been proven experimentally that the detonation limits and the possibility of detonation of gaseous mixtures with large periods of chemical reaction depend on the diameter of the tube. A theoretical substantiation has been given for this effect.

It has been shown that in the detonation of benzene-air mixtures in a tube of large diameter essentially the detonation limits are expanded in comparison with the limits as determined under laboratory conditions for tubes with a diameter of 20 mm. It has been found that a benzene-air mixture detonates under author's experimental conditions within a range of variation of α from 0.5 to 1.82.

From author's summary

6364. Bennett, F. D., Energy partition in the exploding wire phenomena, *Physics of Fluids* **1**, 6, 515–522, Nov./Dec. 1958.

Streak camera and oscillographic circuit-damping data are presented for exploded copper wires varying in diameter from 3 to 8 mils. A maximum of specific shock-wave energy in the induced flow is found at a wire diameter different from that of a minimum in the total damping time of the circuit. This displacement is shown to be caused by the presence of residual circuit resistance. The proof is based on a critical analysis of optimum damping conditions in the exploding wire circuit. A maximum of apparent energy within the contact surface appears at about the same wire diameter as the minimum of total damping time. Discussion of the implications of the Taylor-Lin similarity theory indicates that lack of similarity of the flow is probably connected with the displacement of the maximum energies associated with shock-wave and contact surface. From author's summary

Acoustics

(See also Revs. 6022, 6065, 6227)

6365. Kanwal, R. P., Absorption and dispersion of forced spherical and cylindrical sound waves according to the Navier-Stokes equations, *J. Acoust. Soc. Amer.* **29,** 5, 593–595, May 1957.

6366. Khalatmkov, I. M., and Abrikosov, A. A., Dispersion of sound in a Fermi-liquid (in Russian), *Zh. Eksp. Teor. Fiz.* **33,** 7 (1), 110–115, 1957; *Ref. Zh. Mekh.* no. 4, 1958, Rev. 3844.

Based on the theory of Fermi-liquids, proposed by Landau, an investigation is made of the absorption and dispersion of sound vibrations in such a liquid. Concrete calculations are carried out for the case of liquid He^3. From authors' summary

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6367. Chaudhuri, K. D., Ultrasonic attenuation of metals at low temperatures (in English), *Z. Phys.* **155,** 3, 290–295, 1959.

At very low temperatures when the mean free path of the electrons in metals becomes large but less than the wavelength of sound wave, a relationship between electrical conductivity and attenuation in the normal state has been deduced by Mason using the mean free path associated with the electrical conductivity. Similarly, a relationship between thermal conductivity and attenuation can be deduced using the mean free path associated with the thermal conductivity. It has been shown from experimental results that the relationship thus deduced agrees better in the temperature region discussed in the paper. When the mean free path becomes greater than the wavelength, α_s/α_n, the ratio of superconducting attenuation to that in the normal state can be determined in accordance with the theory of Bardeen, Cooper and Schrieffer. It is apparent from experimental results that in the limited region where the scattering of electrons is predominantly by lattice vibrations, K_s/K_n, the ratio of superconducting thermal conductivity to that in the normal state is equal to α_s/α_n. From author's summary

6368. Papadakis, E. P., Correction for diffraction losses in the ultrasonic field of a piston source, *J. Acoust. Soc. Amer.* **31,** 2, 150–152, Feb. 1959.

In ultrasonic attenuation experiments carried on by the pulse method, it is important to know the part of the measured attenuation contributed by diffraction in the ultrasonic field. In certain cases, particularly at the lower megacycle frequencies, the diffraction loss can be much greater than the attenuation intrinsic to the specimen. The diffraction loss in decibels has been computed elsewhere as a function of the distance the ultrasonic pulse travels back and forth in the sample. Here an expression for the increment to the attenuation is derived taking into consideration at which echoes the decibel drop is measured. It is shown that the first echo has suffered a considerable loss at the lower frequencies and that one must consider that loss in computing the increment to the attenuation caused by diffraction if he has used that echo as one at which the decibel loss is measured. If that loss is not considered, the incremental attenuation will be excessive. From author's summary

6369. Laville, G., Apparatus for the measurement of damping of propagation of ultrasonic sound in liquids (in French), *C. R. Acad. Sci., Paris* **245,** 18, 1523–1526, Oct. 1957.

6370. Powell, A., On the generation of noise by turbulent jets, ASME Aviation Conf., Los Angeles, Calif., Mar. 1959. Pap. 59-AV-53, 23 pp.

Elementary methods are used to provide a fundamental understanding of the salient features of jet noise. Simple reasoning yields information about the total noise power and spectral shape which is in encouraging agreement with experiment. The possibilities of remedying certain deficiencies are discussed, and the failure of existing methods is illustrated by reference to rocket noise. From author's summary

6371. Koenig, R. J., Noise control for Convair 880 and 600 jets, *Noise Control* **5,** 2, 23–27, 50, Mar. 1959.

6372. Hoover, R. M., and Miller, L. N., Noise characteristics of some jet ground operations, *Noise Control* **5,** 2, 28–31, 47, Mar. 1959.

6373. Mull, H. R., Effect of jet structure on noise generation by supersonic nozzles, *J. Acoust. Soc. Amer.* **31,** 2, 147–149, Feb. 1959.

The near noise field of a supersonic jet (Mach 2.87), exhausting into quiescent air, is analyzed with respect to the aerodynamic structure of the jet. The noise field is shown to be shifted away from the jet exit with the most intense sound near the end of the supersonic portion of the exhaust structure. Downstream of this point, the jet radiates noise in the same manner as a subsonic jet. From author's summary

6374. Callaghan, E. E., Noise suppressors for jet engines, *Noise Control* **5,** 1, 18–23, 80, Jan. 1959.

6375. Wolf, H., Acoustic effects produced by airscrews, jet engines and free jets (in German), *Maschinenbautechnik* **7,** 11, 573–580, Nov. 1958.

6376. Watters, B. G., Hoover, R. M., and Franken, P. A., Designing a muffler for small engines, *Noise Control* **5,** 2, 18–22, Mar. 1959.

Micromeritics

(See also Revs. 6163, 6174)

6377. Kuznetsov, P. I., and Tslaf, L. Ia., On the breaking up of a fluid jet into drops, *Soviet Phys.-Tech. Phys.* **3,** 6, 1135–1138, Feb. 1959. (Translation of *Zh. Tekh. Fiz., Akad. Nauk SSSR* **28,** 6, 1220–1223, June 1958 by Amer. Inst. Phys., Inc., New York, N. Y.)

After discussion of previous researches the breaking up process is described as a succession of phenomena: attachment to the nozzle, clear glassy tubular shape, drops existing but not separated, separate drops. Present work deals with factors entering into dispersion of the jet; nozzle diameter, drop diameter (mean value), density of liquid, density of fluid into which the flow takes place, nozzle pressure at orifice, kinematic viscosity of liquid, kinematic

viscosity of surrounding medium, surface tension of liquid sprayed, velocity of liquid upon leaving the nozzle, and the gravitational acceleration. The function connecting these ten quantities has to be determined experimentally. Authors apply to these quantities the Pi-theorem, and form seven dimensionless groups, but finally use only four of them, one of which is the Reynolds number. For cases of air at atmospheric pressure as the surrounding medium the function is dependent only on two dimensionless groups. Applying this function to a number of experiments the interrelations are represented graphically in logarithmic charts. Authors claim for their two-parameter function a better fit of experimental data than was given by functions developed by previous workers.

The paper is too condensed, the experimental values are not given, the data seem to be taken from one single nozzle of the impinging type, and the method of derivation is hazy. The method of determining the mean drop diameter is not given.

K. J. DeJuhasz, Germany

6378. Bond, A. W., The behaviour of suspensions, Parts I, II, Settling suspensions; suspensions in upflow, *Inst. of Engrs., Australia, (Civ. Engng. Trans.)* CE **1,** 1, 1-17, Mar. 1959.

Part I of the paper discusses and develops a theory of the settling of suspensions in still water, tests the theory with experiments on the settling of alum and lime hydroxide floc suspensions, and discusses the application of the theory to the precipitates formed in sedimentation basins.

Part II discusses and develops a theory of the behavior of a suspension in an upflow; illustrates the theory with experiments on the behavior of hydroxide floc suspensions in an expanding upflow; compares their behavior in still water and in an upflow; and discusses the shape of upflow zones.

From author's summary

6379. Paslay, P. R., and Slibar, A., Laminar flow of drilling mud due to axial pressure gradient and external torque, *J. Petroleum Technol.* **9,** 11, 310-317, Nov. 1957.

Using three-dimensional, stress-deformation rate equations for a Bingham plastic, an approximate solution for the laminar flow of drilling mud between the drill pipe and casing is given for the case when the velocity gradients due to axial flow are large compared to velocity gradients due to rotation.

From authors' summary

6380. Skobunov, V. V., An experimental study of the aerodynamics of dust-filled air in mine purifying systems, *Soviet Phys.-Tech. Phys.* **3,** 6, 1139-1143, Feb. 1959. (Translation of *Zh. Tekh. Fiz., Akad. Nauk SSSR* **28,** 6, 1224-1229, June 1958 by Amer. Inst. Phys., Inc., New York, N. Y.)

Fundamental problem of mining ventilation is the removal of impurities, particularly dust, from the air current. Important in this connection is the knowledge of the distribution law in the ventilation current. In numerous investigations it was found that intensity of turbulence, i.e., ratio of root-mean-square eddy velocity to mean-air-current velocity, remains constant over wide range of streaming velocity. Previous Russian researchers found that divergence of instantaneous velocity components satisfies the normal Gaussian distribution law, and the same law expresses also the temperature distribution for a heat substance in a constrained flow. Graphs are shown of spatial distribution of granular emulsion in a horizontal trough, illustrating the Gaussian law. Graphs show also that dust concentration decreases away from axis of dust stream. Using dimensionless coordinates, many sets of data can be represented by a single curve. Fallout of dust particles from ventilation air current under action of its own weight, and also clinging of dust on the walls, are related to random effects and therefore follow to some extent a normal distribution law for dispersed quantities.

The work is rather condensed and not adequately explained. It has the value of giving an extensive list of Soviet literature dealing with this problem.

K. J. DeJuhasz, Germany

Symposium on dust collection and separation (in Swedish), *Tekn. Tidskr.* **89,** 5, Jan. 1959:

6381. Widell, T., Measurement techniques in dust separation (in Swedish), 81-87.

6382. Mansson, B., Dust particles—distribution and efficiency of dust separation (in Swedish), 87-92.

6383. Allander, C., Physical principles of dust separation (in Swedish), 92-97.

6384. Aurivillius, B., Filter (in Swedish), 97-99.

6385. Elvingsson, C.-O., Fibre filters (in Swedish), 99-106.

6386. Rosenblad, G., Dynamical dust separation (in Swedish), 106-115.

6387. Gustavsson, K.-A., Wet dust separation (in Swedish), 115-121.

6388. Bovin, Y., Sampling of dusts and dusty gases (in Swedish), 121-124.

6389. Gokhale, N. R., and Gatha, K. M., Correction for Stokes' law, *Indian J. Phys.* **32,** 11, 521-524, Nov. 1958.

Millikan's correction to Stokes's law for water droplets falling through air has been measured. Some necessary improvements over Millikan's method have been introduced. The present direct measurement yields the value $A = 0.701$ for the relevant correction constant.

From authors' summary

6390. Rausch, W., Investigations of the air resistance of granular and powdered materials in an air stream (in German), *Ing.-Arch.* **26,** 5, 319-332, 1958.

This is an attempt to determine and represent the flow resistance of an airstream carrying small solid particles.

Air resistance of granular and powdered materials increases with increasing fineness, therefore, air resistance is a measure of fineness and vice versa. A mixture is composed of particles of varying sizes and shapes, therefore the air resistance of single particles cannot be simply applied to mixtures. Theory of air resistance for individual particles is discussed for spherical particles, using a chart of drag coefficient as function of Reynolds number. A characteristic number expressing the ratio of air resistance to mixture weight is discussed. Charts are developed for the interrelation of air resistance, relative air velocity, and diameter, for spherical particles. Dimensionless numbers, Reynolds number and Froude number are defined and their significance explained. Experimental determination of air resistance by elutriation and sedimentation by both Gonnel's and Andreasen's methods are described. The disadvantages of these are avoided by Barth's method in which a cylindrical measuring nozzle is inserted into the pipe carrying the suspension, and the pressure drop before and after the nozzle measured. From the pressure differences and the velocity differences the air resistance can be calculated. Apparatus is illustrated and described in detail; calculations fully explained. The method was tested by using commercially obtainable standardized small glass spheres of 90 to 140 micron diameter, and also aluminum silicate of irregular shape of about 70 micron mean dimension. In conclusion, as background information, other methods are described, namely: impulse method of Barth (see Barth,

1958); method of Blaine; method of Carlson, Frazier, and Engdahl; method of Farbar; quantity measuring device of Barth.

The work covers the field, gives a good background, and includes a fairly comprehensive list of literature dealing with European research on the subject.

K. J. DeJuhasz, Germany

Porous Media

(See Rev. 6176)

Geophysics, Hydrology, Oceanography, Meteorology

(See Revs. 6014, 6029, 6119, 6157, 6158, 6160, 6175, 6176, 6234, 6236)

Naval Architecture and Marine Engineering

(See also Revs. 5906, 5994, 6017, 6018, 6019, 6246)

6391. Breslin, J. P., A new interpretation of the free-space pressure field near a ship propeller, Proc. Third U. S. Nat. Congr. Appl. Mech., June 1958; Amer. Soc. Mech. Engrs., 1958, 729–734.

The pressure fluctuations at a point in the vicinity of a propeller operating in a boundless incompressible fluid are found from the velocity potential function. This approach, which yields results in agreement with those obtained by different derivations, has the advantage of enabling one to interpret the character of the pressure field. It is shown that the linearized pressures are purely convective in nature and, hence, the pressure field acts as though it is a "static" distribution which moves with each blade. This result provides some conceptional gain in the application of the free-space field to the action expected on a flat plate. Some broad characteristics of the field are outlined. Detailed evaluation in terms of elliptic integrals is deferred to a later report.

From author's summary

6392. Volker, H., Ship resistance in flowing, shallow water, *Inter. Shipbldg. Prog.* **5,** 52, 577–580, Dec. 1958.

6393. Weinblum, G. P., Applications of wave resistance theory to problems of ship design, *Trans. Instn. Engrs. Ship. Scotland* **102,** 4, 119–158, 1958/59.

The author surveys recent work on the mathematical studies of wave resistance and discusses the results obtained when this is applied to surface displacement and other types of ship.

From author's summary

6394. Faddeev, Yu. I., The application of energetic correlations to investigations of the rolling of ships in continuous rough water (in Russian), *Trudĭ Leningrad Korablestroit. In-ta* no. 18, 159–174, 1956; *Ref. Zh. Mekh.* no. 5, 1958, Rev. 5389.

The general question is examined of the transverse movements of a ship in continuously rough conditions. This appears to be a development of the author's previous work [*Trudĭ Leningr. Korablestroit. In-ta* no. 15, 53–61, 1955]. The solution of the equation for the rolling of a ship is carried out by means of the energetic method; studies were made of the form of the diagram for the static stability with linear and nonlinear relations to the angle of roll and of the analytical relation of the moment of the force of resistance to the angular velocity of the rolling. A graphical-analytical method is proposed for determining the linear amplitude of resonance. Author believes that the method proposed by him gives more exact results than other methods; in addition, the unwieldiness of the calculations is minimized. A numerical example is given for the determination of the resonance amplitude of a fishing trawler of 936 tons, calculated by both the linear and the nonlinear theorems.

V. B. Dragomiretskii

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6395. Lysenko, L. G., Investigation of some questions of stability of passenger-carrying and cargo-passenger-carrying ships for use in inland waterways transport (in Russian), *Trudĭ Leningrad In-ta Inzh. Vodn. Transp.* no. 24, 211–220, 1957; *Ref. Zh. Mekh.* no. 5, 1958, Rev. 5393.

Some deductions are made, on the basis of analysis of field experimental work, regarding the relation of heeling on the circulation for a number of passenger and cargo and passenger-carrying ships used in inland waterways transport, the ships having different ratios of width to draught. The values are obtained of the coefficients entering into the formulas proposed by A. M. Basin and G. A. Firsov for the computation of speed for steady running. An elementary empirical formula is put forward for the calculations of the value of the given shoulder of the heeling pair of ships (the relations of $B:T$ of which were found in the range of 4.5 to 7) on the steady running

$$l_g = Z_g - 5.4T + 1.15B$$

Here l_g is the given shoulder measured from the center of gravity of the ship, Z_g the rise of the center of gravity of the ship from the basic, T the draught of the ship, B the width of the ship (in m). It was established by experiment that the relative diameter of steady running for paddle-wheel vessels is 3–3.5, while for passenger or cargo-passenger-carrying vessels of new construction it is 1.8–2.0. It was established that the magnitude of the angle of heeling in the evolutionary period is 2.2 times greater than this angle in steady running. Integrals for the differential equations are obtained, enabling a determination to be made, with a sufficient degree of accuracy for practical purposes, of the size of the heeling angle at any moment in the transient motion of the ship in running. An indication of stability is proposed which would permit the designer in the initial stages of designing to evaluate the stability of cargo-passenger-carrying double-decker river steamers.

A. M. Rozenfel'd

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6396. Rydill, L. J., A linear theory for the steered motion of ships in waves, *Shipbuilder* **66,** 615, 281–286, Apr. 1959.

6397. St. Denis, M., and Craven, J. P., Recent contributions under the Bureau of Ships fundamental hydromechanics research program. Part III. Control, *J. Ship. Res.* **2,** 3, 1–22, Dec. 1958.

See AMR **12** (1959), Rev. 3183.

6398. Chukhlin, V. P., Equipment of an experimental tank (basin) of the gravitational type (in Russian), *Trudĭ Gor'kovsk. In-ta Inzh. Vodn. Transp.* no. 14, 142–151, 1957; *Ref. Zh. Mekh.* no. 5, 1958, Rev. 5416.

The equipment of the experimental basin (gravitational type) belonging to the Gor'kovsk Institute of Engineers of Water Transport is described. This equipment consists of appliances to test models in motion, models when being towed, towing equipment, systems of slowing-up of models and systems for the return of the model to its initial position. The experimental basin is intended for testing of 3- to 4-m long models of ships in deep water, in

shallow water and in conditions prevailing in a canal (channel). A description is also given of the type of apparatus required for a towing cable according to height and of the preparation of the equipment required for starting a model. D. A. Chumak

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6399. Tothill, J. T., Model tests of Yarrows 80-ft fishing vessel, *Nat. Res. Counc. Canada, Div. Mech. Eng. Rep.* MB-215, 8 pp. + 7 tables + 8 figs., June 1958.

6400. Ochi, K., Model experiments on ship strength and slamming in regular waves, *Shipbuilder* **66,** 615, 257-261, Apr. 1959.

Book—6401. Davydov, V. V., The torsional strength of ships' hull (in Russian), Moscow, Rechnoy Transport, 1955, 244 pp., illus. 12r; *Ref. Zh. Mekh.* no. 2, 1958, Rev. 2261.

The introduction contains a brief historical survey of the development of the analytical theory of thin-walled structures working in torsion, and a fundamental hypothesis is formulated by the author, in which the torsional displacement of the cross section is assumed in the form

$$u = kyz \qquad [*]$$

where the axes y and z are in the plane of the cross section of the hull and the coefficient k is in the general case a function of the coordinate x. Author maintains that the law of torsional displacement [*], as formulated by him, has advantages compared with other, more complicated expressions contained in the literature. The first chapter concerns the methods of determining the torsional moment. Cases are examined of static support on a wave, rolling and pitching in still water, and unequal loading in still water. When determining the bending moment due to rolling and pitching, it is recommended to introduce the amplitudes of the motion. The problem of the reduction in the bending moment by smoothing of the water on the lee side, as well as of the general distortion of the hull structure, are not touched upon. The remaining chapters of the book deal with the determination of the stresses in the hull due to a given torsional moment. The second and third chapters investigate the torsional problem of a single compartment in which the torsional displacement of the end sections is unrestrained, and the relative angle of torsion of the section is determined by

$$k = \frac{\partial^2 u}{\partial x \, \partial y}$$

When solving this problem, author introduces the assumption that the straight lines contained in the cross section remain straight after applying torsion. This postulate agrees with the author's law of torsional displacement for the case of a rectangular cross section. The method of solution consists in the edge displacements acting on each of the six edges of the parallellipiped being determined by static equations, then the displacement (distortion) of the edges is determined, and the required torsional angles found by applying certain geometrical principles. Considering the case of a deck with a hatchway, it is assumed that the parts of the deck in way of the hatch bend in their own plane like beams, while the parts of the deck between hatches, do not experience bending deformation. The fourth chapter expounds the theory of constrained torsion adopted by the author. The conceptions of moments of constraint and center of constraint are introduced; the position of the center of constraint is determined from the condition of static equivalence to zero of the normal stresses arising in the cross section in the presence of constrained torsion; the moment of constraint is defined as the moment of the normal constraining stresses, corresponding to positive values of the coordinates y and z, calculated relatively to the axis of symmetry of the cross section, z. This theory of constrained torsion is applied to the determination of the relative angles of torsion of the cross section when moments of constraint are applied to the compartment; the same types of hull compartments are examined as in the preceding chapters. The fifth chapter contains the torsional analysis of a ship's hull. The hull is considered as a system of compartments, unknown moments of constraint are introduced, and the relative angles of torsion of linked compartments are equated, due both to the torsion of the compartment by external moments applied to the bulkheads, and the unknown moments of constraint; this leads to a system of equations for three moments of constraint.

A. A. Kurdyumov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6402. Arkhangorodskii, A. G., Dependence of the optimum limit of yield of the steel on the principal measurements of a ship (in Russian), *Trudi Nikolaevskogo Korablestroit. In-ta* no. 8, 58-64, 1956; *Ref. Zh. Mekh.* no. 3, 1958, Rev. 3377.

The value is determined of the optimal limit of yield for ships of varying measurements; the initial measurements appear to be only the relation between the weight of the compressed coverings and the limit of yield of the material from which they are made.

From author's summary

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

6403. Batten, B. K., An introduction to fatigue in marine engineering, *Inst. Mar. Engrs, Trans.*, **70,** 11, 331-355, Nov. 1958.

Friction, Lubrication and Wear

(See also Rev. 5872)

Book—6404. Wernitz, W., Friction at a Hertzian contact with combined twist and roll [Walz-Bohrreibung—Bestimmung der Bohrmomente und Umfangskrafte bei Hertz' scher Pressung mit Punkberuhrung], Braunschweig, Friedr. Vieweg & Sohn, 1958, iv + 96 pp. DM 12.80.

In many types of infinitely variable, friction-type transmissions the drive is transmitted through a point contact between hardened surfaces. For instance, a cone and a sphere, or two cones, may form the two turning elements, one of which drives the other through a "point" contact. At the contact one body has, in general, combined spin and roll relative to the other. Book describes research on energy loss at such contacts. Work covers range of spin-roll ratios, range of eccentricities of contact ellipses and a number of lubricants. Results are analyzed by assuming coefficient of friction is uniform over the contact ellipse; coefficient is then calculated from measured energy loss. Comparison with results of other workers, using two ball machine, is made.

Work provides a collection of experimental data which will be valuable to designers of friction gears, rolling bearings, etc. Author does not attempt a full discussion of physical conditions at the contact. The complexity of these conditions result in considerable scatter of experimental points.

D. C. Johnson, England

6405. Ling, F. F., and Saibel, E., On the phenomenon of brake-fading (in English), *ZAMP* **9a,** 4, 315-322, Nov. 1958.

One of the factors affecting the relationship between frictional force acting on a brake drum and pedal pressure is the changes in fractional properties of lining materials due to temperature changes. Loss of braking efficiency due to this effect is known as brake-fade, and a much greater loss after resting brakes for a period following operation at high temperature is known as delayed-fade. Both phenomena are of complex nature and affect seriously the stability of brake.

Authors have attempted a purely mathematical solution to the problem of normal fade by assuming a linear relation between the coefficient of friction and interface temperature above ambient. Considering the problem as that of one-dimensional heat flow in a

semi-infinite body, interface temperature has been expressed in an integral form; and, introducing dimensionless groups, the relationship has been reduced to an integral equation in the unknown of dimensionless sliding velocity. Evaluation of the equation has been done by iteration process to calculate the braking-time and braking-distance.

The method of approach, of course, is very powerful and can be extended to complement the experimental investigation of the problem. Work at MIRA (England) and similar organizations elsewhere has shown that fade is the result of change in operation from dry friction to that of fluid or boundary friction. This approach has led to the introduction of liners offering frictional stability at elevated temperature, pressure, etc. [*Aero. Dig.* **73,** 6, 24–28, Dec. 1956; *Prod. Engng.* **27,** 13, 172–173, Dec. 1956].

Regarding authors' suggestion that the method can be applied to cases of materials for which the coefficient of friction increases with temperature, it may be pointed out that such material is avoided in practice for practical reasons. Slight fall off in coefficient of friction against rise in temperature is rather desirable [*S.A.E. J.* **64,** 6, 40–45, June 1956].

Odier and Leutards' paper [*Soc. Fran. Mec., Bull.* **7,** 23, 23–36, 1957] provides complete solution of problem of instantaneous average surface temperature in braking; authors' simplified relation in the analysis could be replaced by more exact ones.

B. M. Belgaumkar, India

Book—6406. Kamps, R., and Perret, H., Technology of bearings and lubrication [Lager- und Schmiertechnik Insbesondere von Berbrennungsmotoren], Dusseldorf, VDI-Verlag GmbH, 1957.

This book constitutes an almost encyclopedic presentation of the subject of bearing design and application. It is not predominantly mathematical in approach and avoids, for instance, all derivations involved in the hydrodynamic theory of thick-film lubrication. It would serve as an ideal complement to any of the numerous books devoted to the mathematical analysis of the hydrodynamics involved.

Both fluid bearings and antifriction bearings are discussed. In each area the fundamental physical and/or chemical principles are taken at the starting point for the subsequent study. The discussion is supported copiously by the use of research results and current data. Actual computation methods are suggested for specific designs. The thorough exposition on engine bearings includes vibration effects. E. J. McBride, USA

6407. Veiler, S. Ia., and Likhtman, V. I., The action of lubricants in the working of metals under pressure, *Soviet Phys.-Tech. Phys.* **3,** 9, 1860–1868, Apr. 1959. (Translation of *Zh. Tekh. Fiz., Akad. Nauk SSSR* **28,** 9, 2025–2034, Sept. 1958 by Amer. Inst. Phys., Inc., New York, N.Y.)

Paper describes experiments on the drawing of aluminum and copper strip and steel wire. An estimate of friction in strip drawing is made by constructing the die from a pair of rolls which can be locked or freely rotating. It is concluded that for the strip the total drawing force F can be expressed in the form

$$F = p_m \Delta s + \tau_1 s$$

where p_m is a mean pressure closely equal to the Brinell hardness, Δs is the reduction of area, s is the area of contact between strip and die, and τ_1 is the shear strength of a thin surface layer, determined by the properties of the lubricant and any deposited surface films (e.g. tin) and the physical and chemical state of the strip surface.

In the wire-drawing experiments aqueous solutions of saccharose were used as an inactive medium, with sodeum oleate as an additive; the additive was less effective when the viscosity of the base medium was high. With surface-active lubricants, τ_1 decreased with increasing degree of deformation.

It is unfortunate that the authors appear to be unaware of recent wire-drawing investigations outside Russia, such as that of Wistreich [AMR **9** (1956), Rev. 3628], who showed by a split-die technique that friction decreases the die pressure.

G. D. S. MacLellan, Scotland

6408. Milne, A. A., A contribution to the theory of hydrodynamic lubrication, a solution in terms of the stream function for a wedge-shaped oil film, *Wear* **1,** 1, 32–39, 1957.

Author analyzes the infinitely wide plane slider bearing by utilizing the equations of motion and a stream function which satisfies the biharmonic equation and the boundary conditions of the problem. The fluid is assumed to be viscous and incompressible. An exact solution is presented for the general case of arbitrary relative motion between the two surfaces, and expressions are derived for pressure, normal load, and tangential load. For very small angles of inclination the expressions reduce to those forms resulting from the integration of the Reynolds equation. If the angle of inclination is not very small, errors of the order of the square of the angle of inclination are incurred through the use of conventional thin film assumptions. D. F. Hays, USA

6409. Ocvirk, F. W., and DuBois, G. B., Relation of journal bearing performance to minimum oil-film thickness, *NACA TN* 4223, 48 pp., Apr. 1958.

The minimum thickness of the oil film is used as a basic variable in performance curves of plain journal bearings under a steady load. Analytical curves based on the short-bearing approximation and the solution of Cameron and Wood are compared with various experimental data. Load capacity and predicted film thickness at friction-curve hook points are correlated with peak-to-valley surface roughnesses. Analytical curves show the effect of bearing-clearance changes on friction power loss, film thickness, and peak pressure in the oil film. From authors' summary

6410. Maiorov, S. A., and Slomyanskii, G. A., On the gyroscopic effect and rotation of balls in ball bearings (in Russian), *Izv. Akad. Nauk SSSR, Otd. Tekh. Nauk* no. 2, 58–63, Feb. 1958.

The balls in a ball bearing have angular velocities and therefore are subjected to gyroscopic moments. Under certain conditions these moments cause the balls to slide, which speeds-up the wearing out of a bearing. The sliding practically does not occur in radial bearings and is the greatest in thrust bearings. Author considers an angular bearing (a bearing which could carry both radial and axial loads) and derives a formula for the gyroscopic moment of a ball. In this formula the magnitude of the gyroscopic moment is proportional to $\sin \alpha$, where α is the angle between the direction of the load and the axis of the shaft. Assuming that the inner race is mounted on the shaft and the outer race is stationary, author determines the condition at which the gyroscopic sliding would occur and when it could become harmful. At high velocities a ball not only rolls in its groove but also turns about an axis perpendicular to the groove to which it is compressed. Author derives a formula for the angular velocity of turning as a function of the angular velocity of the shaft and of the angle α. According to this formula even for a small angle α, say 12°, when the shaft is turning 30,000 rpm, then the angular velocity of turning of a ball equals 6240 rpm. This angular velocity of turning gives a turning moment which contributes to the wearing out of ball bearings.

T. Leser, USA

Letter to the Editor

6411. Re: AMR **12** (1959), Rev. 3250: **Jacobowitz, J. L., and Mader, C. K., Steady-state creep analysis of the weight loadings of furnace tubes on multiple supports,** *Trans. ASME* **81** B (*J. Engng. Indust.*) no. 2, 115–125, May 1959.

The reviewer wishes to change the sentence reading "The limiting deflection was taken as two times the inside diameter." to read "The limiting creep deflection was taken as equal to the inside diameter of the tube." M. Holt, USA

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CESARI, L., Asymptotic behaviour and stability problems in ordinary differential equations, Berlin, Springer-Verlag, 1959, vii + 271 pp. DM 68. (Paperbound)

Conference on Metallurgical and Engineering Aspects of Weight-saving in Steel Structures, Vol. 66, 1958-59 session, Scotland, West of Scotland Iron and Steel Institute, viii + 197 pp. $6.80.

DAVIES, R., editor, Friction and wear (Proceedings of Symposium held at General Motors Research Laboratories, Detroit 1957), New York, Elsevier Publishing Co., 1959, 191 pp.

FELDMANN, H. D., Fliesspressen von Stahl, Berlin, Springer-Verlag, 1959, viii + 208 pp. DM 31.50.

FENYO, I., Integralegyenletek, Budapest, Tankonyvkiado, 1957, 180 pp. Ft. 17. (Paperbound)

GYORGY, M., Kvantummechanika, Budapest, Muszaki Konyvkiado, 1957, 296 pp.

HAHN, W., Theorie und Anwendung der direkten Methode von Liapunov (Ergebnisse der Mathematik Heft 22), Berlin, Springer-Verlag, 1959, vii + 142 pp. DM 28. (Paperbound)

HOUSNER, G. W., and HUDSON, D. E., Applied Mechanics, Vol. II: Dynamics, 2nd ed., Princeton, New Jersey, D. Van Nostrand Co., Inc., 1959, viii + 392 pp. $5.25.

IOSIPESCU, N., Introducere in Fotoelasticitate, Vol. I, Bucuresti, Institutul de Matematica al Academiei R. P. R., 1958, 190 pp. Lei 6. (Paperbound)

KUHL, H., Probleme des Kreuzstrom-Warmeaustauschers, Berlin, Springer-Verlag, 1959, vii + 83 pp. DM 10.50. (Paperbound)

KANE, T. R., Analytical elements of mechanics, Vol. I, New York, Academic Press, Inc., 1959, xv + 250 pp. $4.75.

MATZ, G., and GAYER, P., Berechnung von gusseisernen emaillierten Druckbehaltern; Messungen an einem 6 cbm-Ruhrwerksbehalter, Berlin, Springer-Verlag, 1959, xvi + 233 pp. DM 37.50.

MILL, C. C., editor, Rheology of disperse systems (Proceedings of a Conference Organized by the British Society of Rheology at University College of Swansea in Sept. 1957), New York, Pergamon Press, 1959, vii + 223 pp. $9.50.

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PRESS, H., Taschenbuch der Wasserwirtshaft, Hamburg, Verlag Wasser und Boden Axel Lindow and Co., 1958, 733 pp.

Proceedings of the conference on the properties of materials at high rates of strain, London, 30 April-2 May 1957; London, Institution of Mechanical Engineers, viii + 268 pp.

Proceedings of Symposium on the Behaviour of Ships in a Seaway, Wageningen, Sept. 7-10, 1957; Vol. I and II, Wageningen, H. Veenman & Zonen, 1959, vi + 1046 pp. (Paperbound)

SANSONE, G., Orthogonal functions; Pure and applied mathematics Vol. IX (translated from the Italian by A. H. Diamond), New York, Interscience Publishers, Inc., 1959, xii + 411 pp. $11.

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SEITZ, F., and TURNBULL, D., editors, Solid state physics; Advances in research and applications, New York, Academic Press, Inc., Vol. 7, 1958, xiv + 525 pp. $12.; Vol. 8, 1959, xiv + 519 pp. $13.50; Vol. 9, 1959, xv + 548 pp. $14.50.

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Symposium on Aluminium Pressure Vessels, London 1958; London, Institution of Mechanical Engineers, 1959, ix + 82 pp. (Paperbound)

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